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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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THE COMING OF AGE OF THE ORIGIN OF SPECIES[1]

MANY of you will be familiar with the aspect of this small green-covered book. It is a copy of the first edition of the "Origin of Species," and bears the date of its production—the first of October, 1859. Only a few months, therefore, are needed to complete the full tale of twenty-one years since its birthday.

Those whose memories carry them back to this time will remember that the infant was remarkably lively, and that a great number of excellent persons mistook its manifestations of a vigorous individuality for mere naughtiness; in fact there was a very pretty turmoil about its cradle. My recollections of the period are particularly vivid; for, having conceived a tender affection for a child of what appeared to me to be such remarkable promise, I acted for some time in the capacity of a sort of under-nurse, and thus came in for my share of the storms which threatened even the very life of the young creature. For some years it was undoubtedly warm work, but considering how exceedingly unpleasant the apparition of the new-comer must have been to those who did not fall in love with him at first sight, I think it is to the credit of our age that the war was not fiercer, and that the more bitter and unscrupulous forms of opposition died away as soon as they did.

I speak of this period as of something past and gone, possessing merely a historical, I had almost said an antiquarian interest. For, during the second decade of the existence of the "Origin of Species," opposition, though by no means dead, assumed a different aspect. On the par of all those who had any reason to respect themselves, it assumed a thoroughly respectful character. By this time the dullest began to perceive that the child was not likely to perish of any congenital weakness or infantile disorder, but was growing into a stalwart personage, upon whom mere goody scoldings and threatenings with the birch-rod were quite thrown away.

In fact, those who have watched the progress of science within the last ten years will bear me out to the full when I assert that there is no field of biological inquiry in which the influence of the "Origin of Species" is not traceable; the foremost men of science in every country are either avowed champions of its leading doctrines, or at any rate abstain from opposing them; a host of young and ardent investigators seek for and find inspiration and guidance in Mr. Darwin's great work; and the general doctrine of Evolution, to one side of which it gives expression, finds in the phenomena of biology a firm base of operations whence it may conduct its conquest of the whole realm of nature.

History warns us, however, that it is the customary fate of new truths to begin as heresies and to end as superstitions; and, as matters now stand, it is hardly rash to anticipate that, in another twenty years, the new generation, educated under the influences of the present day, will be in danger of accepting the main doctrines of the Origin of Species with as little reflection, and it may be with as little justification, as so many of our contemporaries, twenty years ago, rejected them.

Against any such a consummation let us all devoutly pray; for the scientific spirit is of more value than its products, and irrationally-held truths may be more harmful than reasoned errors. Now the essence of the scientific spirit is criticism. It tells us that to whatever doctrine claiming our ascent we should reply, Take it if you can compel it. The struggle for existence holds as much in the intellectual as in the physical world. A theory is a species of thinking, and its right to exist is coextensive with its power of resisting extinction by its rivals.

From this point of view it appears to me that it would be but a poor way of celebrating the Coming of Age of the Origin of Species were I merely to dwell upon the facts, undoubted and remarkable as they are, of its far-reaching influence and of the great following of ardent disciples who are occupied in spreading and developing its doctrines. Mere insanities and inanities have before now swollen to portentous size in the course of twenty years. Let us rather ask this prodigious change in opinion to justify itself; let us inquire whether anything has happened since 1859 which will explain, on rational grounds, why so many are worshipping that which they burned, and burning

[1] A Lecture delivered at the Royal Institution, Friday, March 19.

that which they worshipped. It is only in this way that we shall acquire the means of judging whether the movement we have witnessed is a mere eddy of fashion, or truly one with the irreversible current of intellectual progress, and, like it, safe from retrogressive reaction.

Every belief is the product of two factors: the first is the state of the mind to which the evidence in favour of that belief is presented; and the second is the logical cogency of the evidence itself. In both these respects the history of biological science during the last twenty years appears to me to afford an ample explanation of the change which has taken place; and a brief consideration of the salient events of that history will enable us to understand why, if the "Origin of Species" appeared now, it would meet with a very different reception from that which greeted it in 1859.

One-and-twenty years ago, in spite of the work commenced by Hutton and continued with rare skill and patience by Lyell, the dominant view of the past history of the earth was catastrophic. Great and sudden physical revolutions, wholesale creations and extinctions of living beings, were the ordinary machinery of the geological epic brought into fashion by the misapplied genius of Cuvier. It was gravely maintained and taught that the end of every geological epoch was signalised by a cataclysm, by which every living being on the globe was swept away, to be replaced by a brand-new creation when the world returned to quiescence. A scheme of nature which appeared to be modelled on the likeness of a succession of rubbers of whist, at the end of each of which the players upset the table and called for a new pack, did not seem to shock anybody.

I may be wrong, but I doubt if at the present time there is a single responsible representative of these opinions left. The progress of scientific geology has elevated the fundamental principle of uniformitarianism, that the explanation of the past is to be sought in the study of the present, into the position of an axiom; and the wild speculations of the catastrophists, to which we all listened with respect a quarter of a century ago, would hardly find a single patient hearer at the present day. No physical geologist now dreams of seeking outside the ranges of known natural causes for the explanation of anything that happened millions of years ago, any more than he would be guilty of the like absurdity in regard to current events.

The effect of this change of opinion upon biological speculation is obvious. For, if there have been no periodical general physical catastrophes, what brought about the assumed general extinctions and re-creations of life which are the corresponding biological catastrophes? And if no such interruptions of the ordinary course of nature have taken place in the organic, any more than in the inorganic, world, what alternative is there to the admission of Evolution?

The doctrine of Evolution in Biology is the necessary result of the logical application of the principles of uniformitarianism to the phenomena of life. Darwin is the natural successor of Hutton and Lyell, and the "Origin of Species" the natural sequence of the "Principles of Geology."

The fundamental doctrine of the "Origin of Species," as of all forms of the theory of Evolution applied to biology, is "that the innumerable species, genera, and families of organic beings with which the world is peopled have all descended, each within its own class or group, from common parents, and have all been modified in the course of descent." [1]

And, in view of the facts of geology, it follows that all living animals and plants "are the lineal descendants of those which lived long before the Silurian epoch." [2]

It is an obvious consequence of this theory of Descent with Modification, as it is sometimes called, that all plants and animals, however different they may now be, must, at one time or other, have been connected by direct or indirect intermediate gradations, and that the appearance of isolation presented by various groups of organic beings must be unreal.

No part of Mr. Darwin's work ran more directly counter to the prepossessions of naturalists twenty years ago than this. And such prepossessions were very excusable, for there was undoubtedly a great deal to be said, at that time, in favour of the fixity of species and of the existence of great breaks, which there was no obvious or probable means of filling up, between various groups of organic beings.

For various reasons, scientific and unscientific, much had been made of the hiatus between man and the rest of the higher mammalia, and it is no wonder that issue was first joined on this part of the controversy. I have no wish to revive past and happily forgotten controversies, but I must state the simple fact that the distinctions in cerebral and other characters, which were so hotly affirmed to separate man from all other animals in 1860, have all been demonstrated to be non-existent, and that the contrary doctrine is now universally accepted and taught.

But there were other cases in which the wide structural gaps asserted to exist between one group of animals and another were by no means fictitious; and, when such structural breaks were real, Mr. Darwin could account for them only by supposing that the intermediate forms which once existed had become extinct. In a remarkable passage he says:—

"We may thus account even for the distinctness of whole classes from each other—for instance of birds from all other vertebrate animals—by the belief that many animal forms of life have been utterly lost, through which the early progenitors of birds were formerly connected with the early progenitors of the other vertebrate classes." [3]

Adverse criticism made merry over such suggestions as these. Of course it was easy to get out of the difficulty by supposing extinction; but where was the slightest evidence that such intermediate forms between birds and reptiles as the hypothesis required ever existed? And then probably followed a tirade upon this terrible forsaking of the paths of "Baconian induction."

But the progress of knowledge has justified Mr. Darwin to an extent which could hardly have been anticipated. In 1862, the specimen of *Archæopteryx*, which until the last two or three years has remained unique, was discovered; and it is an animal which, in its feathers and the greater part of its organisation, is a veritable bird, while, in other parts, it is as distinctly reptilian.

In 1868, I had the honour of bringing under your notice, in this theatre, the results of investigations made, up to that time, into the anatomical characters of certain ancient

[1] "Origin of Species," ed. 1, p. 457.
[2] "Origin of Species," ed. 1, p. 458.
[3] "Origin of Species," ed. 1, p. 431.

reptiles, which showed the nature of the modifications in virtue of which the type of the quadrupedal reptile passed into that of the bipedal bird; and abundant confirmatory evidence of the justice of the conclusions which I then laid before you has since come to light.

In 1875, the discovery of the toothed birds of the cretaceous formation in North America, by Prof. Marsh, completed the series of transitional forms between birds and reptiles, and removed Mr. Darwin's proposition that "many animal forms of life have been utterly lost, through which the early progenitors of birds were formerly connected with the early progenitors of the other vertebrate classes," from the region of hypothesis to that of demonstrable fact.

In 1859, there appeared to be a very sharp and clear hiatus between vertebrated and invertebrated animals, not only in their structure, but, what was more important, in their development. I do not think that we even yet know the precise links of connection between the two; but the investigations of Kowalewsky and others upon the development of *Amphioxus* and of the *Tunicata* prove beyond a doubt that the differences which were supposed to constitute a barrier between the two are non-existent. There is no longer any difficulty in understanding how the vertebrate type may have arisen from the invertebrate, though the full proof of the manner in which the transition was actually effected may still be lacking.

Again, in 1859, there appeared to be a no less sharp separation between the two great groups of flowering and flowerless plants. It is only subsequently that the series of remarkable investigations inaugurated by Hofmeister has brought to light the extraordinary and altogether unexpected modifications of the reproductive apparatus in the *Lycopodiaceæ*, the *Rhizocarpeæ*, and the *Gymnospermeæ*, by which the ferns and the mosses are gradually connected with the Phanerogamic division of the vegetable world.

So, again, it is only since 1859 that we have acquired that wealth of knowledge of the lowest forms of life which demonstrates the futility of any attempt to separate the lowest plants from the lowest animals, and shows that the two kingdoms of living nature have a common borderland which belongs to both or to neither.

Thus it will be observed that the whole tendency of biological investigation since 1859 has been in the direction of removing the difficulties which the apparent breaks in the series created at that time; and the recognition of gradation is the first step towards the acceptance of evolution.

As another great factor in bringing about the change of opinion which has taken place among naturalists, I count the astonishing progress which has been made in the study of embryology. Twenty years ago, not only were we devoid of any accurate knowledge of the mode of development of many groups of animals and plants, but the methods of investigation were rude and imperfect. At the present time there is no important group of organic beings the development of which has not been carefully studied, and the modern methods of hardening and section-making enable the embryologist to determine the nature of the process in each case, with a degree of minuteness and accuracy which is truly astonishing to those whose memories carry them back to the beginnings of modern histology. And the results of these embryological investigations are in complete harmony with the requirements of the doctrine of Evolution. The first beginnings of all the higher forms of animal life are similar, and however diverse their adult conditions, they start from a common foundation. Moreover the process of development of the animal or the plant from its primary egg or germ is a true process of evolution—a progress from almost formless to more or less highly organised matter, in virtue of the properties inherent in that matter.

To those who are familiar with the process of development all *à priori* objections to the doctrine of biological evolution appear childish. Any one who has watched the gradual formation of a complicated animal from the protoplasmic mass which constitutes the essential element of a frog's or a hen's egg has had under his eyes sufficient evidence that a similar evolution of the animal world from the like foundation is, at any rate, possible.

Yet another product of investigation has largely contributed to the removal of the objections to the doctrine of Evolution current in 1859. It is the proof afforded by successive discoveries that Mr. Darwin did not overestimate the imperfection of the geological record. No more striking illustration of this is needed than a comparison of our knowledge of the mammalian fauna of the Tertiary epoch in 1859 with its present condition. M. Gaudry's researches on the fossils of Pikermi were published in 1868, those of Messrs. Leidy, Marsh, and Cope on the fossils of the Western Territories of America, have appeared almost wholly since 1870; those of M. Filhol, on the phosphorites of Quercy, in 1878. The general effect of these investigations has been to introduce us to a multitude of extinct animals, the existence of which was previously hardly suspected; just as if zoologists were to become acquainted with a country, hitherto unknown, as rich in novel forms of life, as Brazil or South Africa once were to Europeans. Indeed the fossil fauna of the Western Territories of America bids fair to exceed in interest and importance all other known Tertiary deposits put together; and yet, with the exception of the case of the American tertiaries, these investigations have extended over very limited areas, and at Pikermi were confined to an extremely small space.

Such appear to me to be the chief events in the history of the progress of knowledge, during the last twenty years, which account for the changed feeling with which the doctrine of Evolution is at present regarded by those who have followed the advance of biological science in respect of those problems which bear indirectly upon that doctrine.

But all this remains mere secondary evidence. It may remove dissent, but it does not compel assent. Primary and direct evidence in favour of Evolution can be furnished only by palæontology. The geological record, so soon as it approaches completeness, must, when properly questioned, yield either an affirmative or a negative answer; if evolution has taken place, there will its mark be left; if it has not taken place, there will lie its refutation.

What was the state of matters in 1859? Let us hear Mr. Darwin, who may be trusted always to state the case against himself as strongly as possible.

"On this doctrine of the extermination of an infinitude of connecting links between the living and extinct inhabi-

tants of the world, and at each successive period between the extinct and still older species, why is not every geological formation charged with such links? Why does not every collection of fossil remains afford plain evidence of the gradation and mutation of the forms of life? We meet with no such evidence, and this is the most obvious and plausible of the many objections which may be urged against my theory."[1]

Nothing could have been more useful to the opposition than this characteristically candid avowal, twisted as it immediately was into an admission that the writer's views were contradicted by the facts of palæontology. But, in fact, Mr. Darwin made no such admission. What he says in effect is, not that palæontological evidence is against him, but that it is not distinctly in his favour; and without attempting to attenuate the fact, he accounts for it by the scantiness and the imperfection of that evidence.

What is the state of the case now, when, as we have seen, the amount of our knowledge respecting the mammalia of the Tertiary epoch is increased fifty-fold, and in some directions even approaches completeness?

Simply this, that if the doctrine of Evolution had not existed palæontologists must have invented it, so irresistibly is it forced upon the mind by the study of the remains of the Tertiary mammalia which have been brought to light since 1859.

Among the fossils of Pikermi, Gaudry found the successive stages by which the ancient civets passed into the more modern hyænas; through the Tertiary deposits of Western America, Marsh tracked the successive forms by which the ancient stock of the horse has passed into its present form; and innumerable less complete indications of the mode of evolution of other groups of the higher mammalia have been obtained.

In the remarkable memoir on the Phosphorites of Quercy, to which I have referred, M. Filhol describes no fewer than seventeen varieties of the genus *Cynodictis*, which fill up all the interval between the viverine animals and the bear-like dog *Amphicyon*; nor do I know any solid ground of objection to the supposition that in this *Cynodictis-Amphicyon* group we have the stock whence all the Viveridæ, Felidæ, Hyænidæ, Canidæ, and perhaps the Procyonidæ and Ursidæ, of the present fauna have been evolved. On the contrary, there is a great deal to be said in its favour.

In the course of summing up his results, M. Filhol observes[2]:—

"During the epoch of the phosphorites, great changes took place in animal forms, and almost the same types as those which now exist became defined from one another.

"Under the influence of natural conditions of which we have no exact knowledge, though traces of them are discoverable, species have been modified in a thousand ways: races have arisen which, becoming fixed, have thus produced a corresponding number of secondary species."

In 1859, language of which this is an unintentional paraphrase, occurring in the "Origin of Species," was scouted as wild speculation; at present, it is a sober statement of the conclusions to which an acute and critically-minded investigator is led by large and patient study of the facts of palæontology. I venture to repeat what I have said before, that, so far as the animal world is concerned, Evolution is no longer a speculation, but a statement of historical fact. It takes its place alongside of those accepted truths which must be taken into account by philosophers of all schools.

Thus when, on the first day of October next, the "Origin of Species" comes of age, the promise of its youth will be amply fulfilled; and we shall be prepared to congratulate the venerated author of the book, not only that the greatness of his achievement and its enduring influence upon the progress of knowledge have won him a place beside our Harvey; but, still more, that, like Harvey, he has lived long enough to outlast detraction and opposition, and to see the stone that the builders rejected become the head-stone of the corner.

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[1] "Origin of Species, ed. 1. p. 463.

[2] This passage was omitted in the delivery of the lecture.

ON MULTIPLE SPECTRA

"Nunc age, quo motu genitalia materiai
Corpora res varias gignant, genitasque resolvant
Et qua vi facere id cogantur."
Lucretius, ii., 61–2.

"Prima moventur enim per se primordia rerum:
Inde ea, quæ parvo sunt corpora conciliatu,
Et quasi proxima sunt ad vireis principiorum,
Ictibus illorum cæcis impulsa cientur
Ipsaque, quæ porro paulo maiora, lacessunt."
Lucretius, ii. 132–6.

"It is conceivable that the various kinds of matters, now recognised in different elementary substances, may possess one and the same ultimate or atomic molecule existing in different conditions of movement.

"The essential unity of matter is an hypothesis in harmony with the equal action of gravity upon all bodies."—*Graham's Researches*, p. 299.

In a recent paper[1] I showed that a study of the minute anatomy of spectra, both terrestrial and celestial, forces upon us the conclusion that both in the electric arc and in the hottest region of the sun the so-called chemical elements behave after the manner of compound bodies.

I then dealt more especially with the question of the basic lines in the various spectra, and it is clear that if, at any one temperature, there be some lines only truly basic in the spectrum of any element, we at once divide the lines visible at that temperature into two groups, those which are basic and those which are not. This would give a compound origin to the lines, and this is the real point.

It is now years ago since the view was first held that the elementary bodies had double spectra, that is, that each, or at all events several, under changed conditions of temperature or electric tension, gave us now a fluted spectrum and now one composed of lines.

I glimpsed the idea some time afterwards that the line spectrum was in its turn in all probability a complex whole, in other words that it was the summation of the spectra of various molecular groupings.

Recent work has to my mind not only shown that this is true, but that in the case of many bodies the complexity, and therefore the number, of the molecular groupings which give rise to that compound whole called a line spectrum, is considerable.

It is therefore important from my point of view to reconsider the evidence on which the assertion that the

[1] "On the Necessity for a New Departure in Spectrum Analysis" (NATURE, vol. xxi. p. 8).

fluted bands and the line spectrum (taken as a whole) of a substance really belong to that substance, because if we find that this must be accepted and that it can easily be explained on the view that the two kinds of spectra are produced by different molecular groupings, the fact of other molecular groupings giving rise to a complex line spectrum can be more readily accepted, contrary though it be to modern "chemical philosophy," as taught at all events in the text-books.

Plucker and Hittorf were, I believe, the first to point out that the same chemical substance, when in a state of gas or vapour, gave out different spectra under different conditions. On this point they wrote fifteen years ago:—

"The first fact which we discovered in operating with our tubes . . . was the following one:—

"*There is a certain number of elementary substances which, when differently heated, furnish two kinds of spectra of quite a different character, not having any line or any band in common.*

"The fact is important, as well with regard to theoretical conceptions as to practical applications—the more so as the passage from one kind of spectrum to the other is by no means a continuous one, but takes place abruptly. By regulating the temperature you may repeat the two spectra in any succession *ad libitum*." (Plucker and Hittorf on the Spectra of Ignited Gases and Vapours: *Phil. Trans.* Royal Society, 1865, part i. p. 6.)

Ångström, whose name must ever be mentioned with the highest respect by any worker in spectrum analysis, was distinctly opposed to this view, and in the text which accompanies his *Spectre Normal* we find the following statement—

"Dans un Mémoire sur les spectres 'doubles' des corps élémentaires que nous publierons prochainement, M. Thalén et moi, dans les Actes de la Société des Sciences d'Upsal, nous traiterons d'une manière suffisamment complète les questions importantes qu'on peut se proposer sur cet intéressant sujet. Pour le présent, je me borne à dire que les résultats auxquels nous sommes arrivés, ne confirment aucunement l'opinion émise par Plücker, qu'un corps élémentaire pourrait donner, suivant sa température plus ou moins élevée, des spectres tout-à-fait différents. C'est le contraire qui est exact. En effet en augmentant successivement la température, on trouve que les raies varient en intensité d'une manière très-compliquée, et que, par suite, de nouvelles raies peuvent même se présenter, si la température s'élève suffisamment. Mais, independamment de toutes ces mutations, le spectre d'un certain corps conservera toujours son caractère individuel."[1]

Ångström did not object merely on theoretical grounds. He saw, or thought he saw, room to ascribe all these fluted spectra to impurities.

He was strengthened in this view by observing how, in the case of the spectra of known compounds, there were always flutings in one part of the spectrum or another; a rapid induction naturally, therefore, ascribed all flutings to compounds. The continuity of the gaseous and liquid states of matter, let alone the continuity of Nature's processes generally, never entered into the question. For Ångström, as for the modern chemist, there was no such thing as evolution, no possibility of a close physical relationship between elements, so called, driven to incandescence from the solid state, and binary compounds of those elements.

[1] Ångström sur "Le Spectre normal du Soleil," page 39.

In a memoir, however, which appeared after Ångström's death, and which, though under a different title, was in all probability the one referred to, this opinion was to a large extent recalled, and in favour of Plucker's view, in the following words:—

". . . Nous ne nions certainement pas qu'un corps simple ne puisse dans certains cas donner différents spectres. Citons, par exemple, le spectre d'absorption d'iode que ne ressemble en aucune façon au système des raies brillantes du même corps, obtenues au moyen de l'électricité; et remarquons de plus qu'en général tout corps simple, presentant la propriété d'allotropie, doit donner à l'état d'incandescence des spectres différents, pourvu que la dite propriété de la substance subsiste non seulement à l'état gazeux du corps, mais encore à la température même de l'incandescence. . . .

"Le soufre solid possède, somme on sait, plusieurs états allotropiques, et, d'après certaines observations, ce corps, même à son état gazeux, prendrait des formes différentes. Par conséquent, en supposant que cela soit vrai, le soufre gazeux doit donner plusieurs spectres d'absorptio, tandis que la possibilité d'un seul on de plusieurs spectres brillants dépendra de la circonstance suivante, savoir si les états allotropiques plus complexes de cette substance supporteront la température de l'incandescence, avant de se décomposer.

"Il est bien évident que les cas dont nous venons de parler, ne forment pas une exception à la loi générale énoncée ci-dessus, savoir que chaque corps simple ne peut donner qu'un seul spectre. En effet, si l'on suppose que l'état allotropique est dû à la constitution moléculaire du corps, soit que les molécules se combinent les unes avec les autres, soit qu'elles s'arrangent entre elles d'une certaine manière, cet état allotropique possèdera au point de vue spectroscopique, toutes les propriétés significatives d'un corps composé, et par conséquent il doit être décomposé de la même façon que celui-ci par les effets de la décharge disruptive de l'électricité."[1]

I say that in this paper Ångström recalled his own in favour of Plucker's view, because (as it has been remarked by Dr. Schuster[2]) the word "element" is used in a special sense—because in reality allotropic states are classed as compounds, that particular allotropic state which is to be regarded as truly elemental not being stated, nor any reason given why one should be thus singled out.

In the letter to which I have just referred Dr. Schuster gives an instance in which in order to show that elementary bodies did not really possess two spectra, a double spectrum was assigned to an acknowledged compound; the fluted spectra of hydrogen and carbon which differ from each other as widely as fluted spectra can, being both ascribed to acetylene.

Salet in his admirable work on the Spectra of the Metalloids,[3] was driven to the conclusion that many of these bodies must be held to possess two spectra. His conclusions are thus expressed:—

"Nous avons comparé le spectre d'absorption du brome et de l'iode à leur spectre électrique, et cette comparaison nous semble mettre hors de doute la possibilité des spectres doubles. . . .

"Nous avons obtenu, par voie électrique, un spectre primaire de l'iode correspondant à son spectre d'absorption. Le soufre, le sélénium et le tellure nous ont offert des spectres de combustion très-analogues aux spectres primaire obtenus par voie électrique, mais différant essentiellement des spectres des lignes. . . .

[1] Ångström and Thalén's "Recherches sur les Spectres des Métalloides," p. 5.
[2] NATURE, vol. xv. p. 447.
[3] *Ann. de Chimie et de Physique*, 1873, vol. xxviii. p. 1.

"Nous avons produit le spectre primaire de l'azote avec différents corps qui n'ont absolument de commun que l'azote ; nous pensons donc avoir démontré qu'il appartient bien réellement à ce métalloïde." (*Annales de Chemie et de Physique*, 4 série, tome xxviii. pp. 70, 71).

In 1868 Wullner[1] gave his attention to this subject, and strongly supported Plucker's view of the existence of double spectra, indicating at the same time that the difference of temperature must be regarded as the sole cause of the phenomenon, adding, however, "a decomposition with further elements is not to be thought of." In the case of hydrogen he showed that the banded spectrum ascribed to acetylene really depended upon a change in the emissive power brought about by an alteration of temperature. Touching oxygen, he showed that three distinct spectra may be obtained, while in nitrogen two are observed.

I may say that in my early laboratory experiments I was at first led to think that, in the case of metallic vapours, Ångström's first expressed opinion was correct, and I said so. But after more experience and knowledge had been acquired, I was compelled by the stern logic of facts to abandon it, and I showed, first, that more "orders" of spectra—to use Plucker's term—were necessary, and then that the line spectrum itself was in all probability compound ; that is, that it was in some cases built up by the vibration of dissimilar molecules, some of which might even give us a fluted spectrum, if we could study them alone.

Although, however, in the views I have expressed on former occasions I have had the advantage of the support of the opinion of Plucker and Ångström, and later of Dr. Schuster,[2] not to mention others, I am aware that though there is a general consensus among spectroscopic workers that double spectra cannot be ascribed to impurities, it is not absolute.

I propose therefore in this place to refer to a special case in which this question has been recently brought prominently forward.

I have already stated that Ångström, who was the first to map the line-spectrum of carbon, ascribed the flutings ordinarily seen in the carbon compounds to acetylene.

Now Attfield, in 1862, as a result of a most carefully conducted and admirably-planned set of experiments, came to the conclusion that the flutings were really due to carbon: in short, that carbon, like hydrogen, iodine, sulphur, nitrogen, and other bodies, had a fluted spectrum as well as one consisting wholly of lines.

The work of Attfield will be gathered from the following extract from his paper (*Phil. Trans.*, vol. clii. part 1, p. 221 *et seq.*):—

"On recently reading Swan's paper by the light that Professors Bunsen and Kirchhoff have thrown on the subject, I came to the conclusion that these bands must be due to incandescent carbon vapour ; that, if so, they must be absent from flames in which carbon is absent, and present in flames in which carbon is present ; that they must be observable equally in the flames of the oxide, sulphide, and nitride as in that of the hydride of carbon ; and, finally, that they must be present whether the incandescence be produced by the chemical force, as in burning jets of the gases in the open air, or by the electric force, as when hermetically-sealed tubes of the gases are exposed to the discharge of a powerful induction-coil. . . .

"To establish the absolute identity of the hydro- and nitro-carbon spectra, excluding of course the lines due to nitrogen, they were simultaneously brought into the field of the spectroscope: one occupying the upper, and the other the lower half of the field.

"This was readily effected after fixing the small prism, usually supplied with spectroscopes, over half of the narrow slit at the further end of the object-tube of the instrument. The light from the oxyhydrocarbon flame was now directed up the axis of the tube by reflection from the little prism, while that from the oxynitrocarbon flame passed directly through the uncovered half of the slit. A glance through the eye-tube was sufficient to show that the characteristic lines of the hydrocarbon spectrum were perfectly continued in the nitrocarbon spectrum. A similar arrangement of apparatus, in which the hydrocarbon light was replaced by that of pure nitrogen, showed that the remaining lines of the nitrocarbon spectrum were identical with those of the nitrogen spectrum. In this last experiment the source of the pure nitrogen light was the electric discharge through the rarefied gas.

"The above experiment certainly seemed to go far towards proving the spectrum in question to be that of the element carbon. Nevertheless, the ignition of the gases having been effected in air, it was conceivable that hydrogen, nitrogen, or oxygen had influenced the phenomena. To eliminate this possible source of error, the experiments were repeated out of contact with air. A thin glass tube 1 inch in diameter and 3 inches long, with platinum wires fused into its sides, and its ends prolonged by glass quills having a capillary bore, was filled with pure dry cyanogen, and the greater portion of this gas then removed by a good air-pump. Another tube was similarly prepared with olefiant gas. The platinum wires in these tubes were then so connected with each other that the electric discharge from a powerful induction-coil could pass through both at the same time. On now observing the spectra of these two lights in the simultaneous manner previously described, the characteristic lines of the hydrocarbon spectrum were found to be rigidly continued in that of the nitrocarbon. Moreover, by the same method of simultaneous observation, the spectrum of each of these electric flames, as they may be termed, was compared with the corresponding chemical flames, that is, with the oxyhydrocarbon and oxynitrocarbon jets of gas burning in air. The characteristic lines were present in every case. Lastly, by similar inter-observation a few other lines in the electric spectrum of the hydrocarbon were proved to be due to the presence of hydrogen, and several others in the electric spectrum of the nitrocarbon to be caused by the presence of nitrogen. . . ."

"The spectrum under investigation having then been obtained in one case when only carbon and hydrogen were present, and in another when all elements but carbon and nitrogen were absent, furnishes, to my mind, sufficient evidence that the spectrum is that of carbon."

"But an interesting confirmation of the conclusion just stated is found in the fact that the same spectrum is obtained when no other elements but carbon and oxygen are present, and also when carbon and sulphur are the

[1] *Phil. Mag.*, sec. 4, vol. xxxvii. p. 405.

[2] Dr. Schuster's recently published investigations are as follows:—

Mr. Lockyer's investigations have shown that most bodies give us a continuous spectrum, as a gas, before they condense, and many at a considerable temperature above the boiling point. *Mr. Lockyer has rightly drawn the conclusion from these facts, that the atomic aggregation of the molecules is the cause of the different orders of spectra.*

That the discontinuous spectra of different orders (line and band spectra) are due to different molecular combination, I consider to be pretty well established, and analogy has led me (and Mr. Lockyer before me) to explain the continuous spectra by the same cause; for the change of the continuous spectrum to the line or band-spectrum takes place in exactly the same way as the change of spectra of different orders into each other. Analogy is not a strong guide, yet some weight may be given to it in a case like the one under discussion, where experiment hitherto has failed to give a decided answer. (Dr. A. Schuster on the Spectra of Metalloids, *Phil. Trans.* Royal Society, 1879. Part i page 38 and 89, note.)

only elements under examination. And first with regard to carbon and oxygen. Carbonic oxide burned in air gives a flame possessing a continuous spectrum. A mixture of carbonic oxide and oxygen burned from a platinum-tipped safety-jet also gives a more or less continuous spectrum, but the light of the spectrum has a tendency to group itself in ill-defined ridges. Carbonic oxide, however, ignited by the electric discharge in a semi-vacuous tube, gives a bright sharp spectrum. This spectrum was proved, by the simultaneous method of observation, to be that of carbon plus the spectrum of oxygen. With regard to carbon and sulphur almost the same remarks may be made. Bisulphide of carbon vapour burns in air with a bluish flame. Its spectrum is continuous. Mixed with oxygen and burned at the safety-jet, its flame still gives a continuous spectrum, though more distinctly furrowed than in the case of carbonic oxide; but when ignited by the electric current its spectrum is well defined, and is that of carbon plus the sulphur. That is to say, it is the spectrum of carbon plus the spectrum that is obtained from vapour of sulphur when ignited by the electric discharge in an otherwise vacuous tube."

"Having thus demonstrated that dissimilar compounds containing carbon emit, when sufficiently ignited, similar rays of light, I come to the conclusion that those rays are characteristic of ignited carbon vapour, and that the phenomena they give rise to on being refracted by a prism is the spectrum of carbon."

This question was next taken up by Morren. He wrote[1] (in 1865) fifteen years ago :—

"A la réception de cet intéressant et substantiel Mémoire, j'avoue que je ne regardai pas d'abord comme fondée l'assertion de M. Attfield. . . .

"Je me suis donc mis au travail avec la pensée préconçue de combattre l'assertion émise par le savant anglais ; mais pas du tout, il résulte au contraire des expériences auxquelles je me suis livré que M. Attfield a raison, et que c'est bien la vapeur du carbone qui donne le spectre indiqué plus haut. . . .

"Si on fait brûler le cyanogène au moyen du chalumeau à deux courants, en faisant arriver au centre de la flamme du cyanogène un courant d'oxygène très-pur (cette condition est indispensable), on voit se produire un des plus beaux effets de combustion possible, et cette expérience est certainement une des plus magnifiques qu'on puisse réaliser sur la combustion des gaz. Il se produit, au milieu de la flamme *rosé-violâtre* du cyanogène, une boule d'un blanc vert éboulissant qui rappelle la lumière électrique produite par le courant de la pile entre deux charbons de cornue. Si le spectroscope est dirigé sur cette brillante lumière, on aperçoit, avec une splendeur merveilleuse, le même spectre de la partie bleue des flammes hydrocarburées. Ainsi donc c'est du charbon seul, mais à l'état de vapeur, qui forme cette boule brillante qui plus loin, par son union avec l'oxygène, va passer à l'état d'acid carbonique. Du reste ce spectre n'est pas seul; avec lui on voit, mais très-effacé, le spectre spécial du cyanogène, et celui-ci tend de plus en plus à disparaître à mesure que l'oxygène arrive avec plus d'abondance et brûle de mieux en mieux le cyanogène. Quant au spectre de l'azote, on ne l'aperçoit pas dans cette vive lumière. Le magnifique éclat de ce beau spectre, le plus beau qu'il m'ait été donné de voir, permet de bien comprendre l'aspect creusé et ombré avec une teinte croissante qu'on remarque dans les parties qui n'ont pas de raies brillantes, et même entre ces raies."

Four years later Dr. Watts devoted himself to this subject, and in 1869 his work was thus summarised by himself :[2]—

[1] *Annales de Chimie et de Physique*, 4 série, tome iv. p. 309, 312.
[2] *Phil. Mag.*, October, 1869.

"This spectrum [that consisting of the flutings in question] may be obtained from the flame of any hydrocarbon, though in many cases, owing to the faintness of the spectrum, only some of the groups can be recognised. In the flame of an ordinary Bunsen burner δ and ϵ are easily seen, γ and f are much fainter, and the red group cannot be detected.

"This spectrum is proved to be that of carbon, inasmuch as it can be obtained alike from compounds of carbon with *hydrogen*, with *nitrogen*, with *oxygen*, with *sulphur*, and with *chlorine*. I have obtained it, namely, from each of the following compounds :—olefiant gas, cyanogen, carbonic oxide, naphthalin, carbonic disulphide, carbonic tetrachloride, amylic alcohol, and marsh-gas."

That these conclusions, successively arrived at by Attfield, Morren, and Watts, are sound, I shall show in my next notice. J. NORMAN LOCKYER

(*To be continued.*)

SCIENCE IN PARLIAMENT

THE House of Commons is now complete; all the boroughs and counties have made their choice, and the composition of the new Parliament has been and will be criticised from many points of view. So far as the interests of science and of what we conceive to be good education are concerned, there is, we fear, little difference between the present House of Commons and its predecessor ; just a thin ray of light athwart a cloud of darkness, a tiny morsel of knowledge in a mass of ignorance. This ignorance, however, we are bound to believe is not wilful ; we must admit that our new rulers are willing to be enlightened, unless in time they should show themselves otherwise disposed.

On this ground, as well as on others, it is to be lamented that one of the most eminent and useful scientific members of the House has lost his seat through some local caprice. The absence of Sir John Lubbock from the new Parliament is one we are sure every true lover of science will deplore. Where there is so much ignorance to be overcome, it seems to us we cannot have too many representatives of science in Parliament; and we are sure all who desire to see science advanced in this country would welcome any chance of getting Sir John back to his old place. Such an opportunity has, some may think almost providentially, presented itself in the vacancy that has occurred in the representation of London University by the promotion of Mr. Lowe to "another place." Several candidates have been proposed for the vacant seat, but alongside of Sir John Lubbock all must strike an impartial onlooker as singularly unsuitable. The "doctors" have been attempting to put in a strong claim to have themselves specially represented, supporting their cause, so far as London University is concerned, by somewhat shaky statistics. But medicine has no lack of friends in both Houses of Parliament ; the claims which it has on the country are patent to all, and it is, moreover, included under the wider region of science. If the latter gets fair play from Government, medicine need have no fear that her claims will be neglected. Already are two Scottish universities represented by Dr. Lyon Playfair, who is nothing if not medical. Not one of our English universities has a man of science as its representative, and it is surely important that an institution in which science holds so prominent

a place as London University should have a scientific man for its representative. Sir George Jessel has for some reason a few strenuous advocates, who seem to forget that their candidate resigned his seat for Dover on the ground that it was contrary to the spirit of the act. Sir George is an excellent lawyer, but there are already too many of them in Parliament. Sir John Lubbock has already been fourteen years member of the Senate, and nearly eight vice-chancellor; thus by returning him not only would the London University confer a benefit on Parliament and the country at large, but at the same time would do the best they could for their own interests. We need not here insist on the claims of Sir John as a man of science; his eminence in this department, as well as a man of business is, known to all. He is indeed so many-sided that he would represent as few others could the different faculties which combine to form the London University. His career in Parliament has been marked by a large number of measures which he has carried through Parliament, all of them of a kind more or less affecting the alumni of London University, and several of them directly affecting those very medical men that would now turn their backs upon him. Sir John has been officially connected with various bodies and various movements having for their object the promotion of learning and science, and now we believe he has had the great honour of being designated as President of the British Association for its jubilee meeting at York next year. We should have thought that for a body like the members of London University it would have been unnecessary to point out Sir John Lubbock's claims upon them, and his peculiar fitness to represent them in Parliament. We are confident that all the scientific members of the institution will record their votes in his favour, and by sending him to Parliament strengthen the hands of the few who are intelligently convinced of the necessity of introducing and carrying out those reforms which are so much needed in the attitude of Government towards science and education.

WURTZ'S "CHEMISTRY"

Elements of Modern Chemistry. By Adolphe Wurtz. Translated and edited by Wm. H. Greene, M.D. (London: W. Swan Sonnenschein and Allen, 1880.)

M. WURTZ is one of the recognised leaders of modern chemistry: a text-book from his pen is sure to be hailed with interest and pleasure.

The reputation of the author as an original thinker and worker in chemical science leads one to look for something more than the ordinary orthodox collection of oft-repeated facts in any work bearing his name. And the opening pages of the book before us are certainly very refreshing. Simple and commonly-occurring facts are clearly and simply stated, and on these, as a basis, is aid at once the foundation of chemical theory.

The leading features of the book are, clearness of statement, selection of typical facts from among the vast array at the service of the chemical compiler, and devotion of a comparatively large space to chemical theory and to generalisations which are usually dismissed in a few words in the ordinary text-book.

Perhaps the most remarkable feature of M. Wurtz's book is that, notwithstanding that within less than 700 moderate-sized pages there is given an account of the leading properties of all the more important substances known to chemistry, the book is nevertheless exceedingly interesting and eminently readable. Probably this result could only be attained by a French writer.

In a very early part of the book the modern theory of valency or equivalency is explained, and this theory pervades the whole of the work. The great objection to the book, considered as an exponent of modern chemistry, in our opinion, is this marked devotion to one favourite theory. The objection which we should make to the book, considered more broadly as a scientific treatise, is that theoretical considerations are too much treated as identical with facts, and that facts are, seemingly, supposed to be explained when they are only stated in the language of that peculiar theory which finds in such expressions as "exchange of affinities," "satisfaction of bonds," &c., an *explanation* of chemical phenomena. The theory of valency assumes that the molecular weights of those compounds which are employed in determinations of valency are known. But at present we know the molecular weights of gasifiable bodies only; hence no exact conclusions concerning valencies can be drawn from a study of non-gasifiable compounds. Nevertheless M. Wurtz appears to regard the formulæ of many non-volatile metallic oxides as on an equal footing with those of such compounds as water, hydrochloric acid, &c., and as just as serviceable for determinations of elementary valencies.

Indeed we do not find given a clear definition of molecular weight as distinguished from atomic weight. Avogadro's hypothesis, it is true, is mentioned, but not clearly stated as the basis of the modern system of molecular weight determinations. And without a definition of molecular weight, clearly established, it is impossible to grasp the modern acceptation of the term atomic weight.

In such a work as this one might reasonably look for a statement of the results of the recent work, of first-rate importance, of Guldberg and Waage, and of Ostwald, on Chemical Affinity, more especially as the subject of mass action is mentioned and Berthollet's laws are detailed.

The general subject of affinity is somewhat vaguely treated. Thermal chemistry scarcely finds any recognition in the work.

It may seem invidious to mention faults of detail; but there are a few which, we think, might very profitably be corrected in a second edition.

The nomenclature of the oxyacids of sulphur is certainly erroneous: hyposulphurous acid—H_2SO_2—is called hydrosulphurous, and thiosulphuric—$H_2S_2O_3$—hyposulphurous. The nomenclature of the oxides of iodine is also peculiar, and the formulæ of the known oxides are somewhat startling: perbromic acid is still enumerated among the oxyacids of bromine. Dry sulphuretted hydrogen is said to be energetically decomposed by iodine. SO_2 is called sulphurous oxide *or* sulphurous acid gas; and, lastly, Lavoisier is said to have determined the composition of water in 1785.

That part of the book which deals with the carbon compounds is not so satisfactory as the portion treating of inorganic chemistry. The classification is most unnatural, and the treatment of many important groups, *e.g.*, the alcohols and terpenes, is unsatisfactory.

We should not think it possible for an average student

of chemistry, beginning the study of the carbon compounds with the aid of this manual, to gain any but most hazy ideas regarding the general scope of this branch of the science.

But notwithstanding such defects as those we have mentioned there can be little doubt that M. Wurtz's book is possessed of many admirable qualities. In place of masses of unconnected facts he presents the student with carefully-selected leading data; he may, we think, strain some of his favourite theories too much, yet he inculcates the paramount necessity of theoretical explanations; he gives prominence to generalisations, such as equivalents, combining weights, and laws of multiple proportions, nomenclature and notation, bases, acids, and salts, &c., &c., and these he develops historically with great clearness and rare felicity of illustration; and he gives just sufficient detail concerning chemical manufactures as suffices to render these intelligible to the ordinary student of chemistry.

The translation appears to be admirably executed. The book is well printed, and the illustrations are distinct. But why should one be led to believe that spirit-lamps and charcoal-furnaces are still the ordinary appliances for raising the temperature of substances in chemical laboratories?

In reading the historical notes which are given concerning most of the important compounds and generalisations of chemistry, one is almost persuaded to believe that, after all, "chemistry is a French science."

M. M. P. M.

OUR BOOK SHELF

The Geological Antiquity of Insects. Twelve Papers on Fossil Entomology. By Herbert Goss, F.L.S. 8vo, pp. 1-50. (London: John Van Voorst, 1880.)

THIS bulky pamphlet must prove decidedly useful both to geologists and entomologists. The subject of fossil entomology has of late assumed gigantic proportions, and asserted an importance little dreamt of when palæontology first substantiated its claims as the real guide to geologists in determining the nature of many strata. Indeed, as is truly stated by Mr. Goss, the wonder is that remains of any animals so fragile as insects could have been preserved sufficiently for scientific purposes; yet we find contemporaneous with the remains of those marvellous Devonian fishes those of the earliest types of insects, chiefly only wings, it is true, but wings in such a complete state of preservation that the intricacies of neuration can be traced; and this neuration is in some cases so difficult to homologise with that of existing forms that a separate, supposed extinct order (*Palæodictyoptera*) has been formed (probably unnecessarily) for the reception of these remains. Mr. Goss has given detailed accounts (with copious references) of almost every described species of fossil insect from the older formations, and has contrived to very lucidly place before his readers the sequence of appearance of the now-existing orders according to the testimony of the rocks. As we ascend in the geological scale the indications become less complete, and only genera, or eventually only families, are alluded to, but always with the same copious references to authorities. It could not be otherwise. As we ascend the materials increase enormously, until at last, in the post-tertiary system, we find ourselves in the presence of remains that have been identified with species now living in the same district; and in somewhat less recent strata in North America the multitude of fossil remains of insects is such as to place it out of the question that any detailed account could be given of them. Not the least useful feature in the work consists in the notes on the correlation of special insect-forms with the most remarkable animal and vegetable relics from the same formations.

This pamphlet has no claims as embodying the results of original research; it is a useful concentrated compilation from the literature on the subject by one who evidently has an intelligent knowledge of it both in its geological and zoological aspects, and as such cannot fail to be of service as a text-book, giving the student a clear outline sketch, and the references where to seek more detailed information. Such a work is often more useful than original essays, which, from the magnitude of the subject, can only be limited in their aim. The treatment may be a little unequal, and we think it would be possible to point out cases in which certain fossil-insects have been referred to a wrong position; but this is the fault of the original describers.

We are rather sorry to see that all notice of Amber-Insects is intentionally omitted for the present, more especially as, from the medium in which they are preserved, these are the most perfect of all fossil insect-remains. They consist for the most part of well-marked existing genera, but we think no one has yet dared to identify any amber-insect with an existing species. In connection with this subject one word of caution to palæontologists with regard to many fossil insects. We find many insects (excluding those in amber) referred to modern genera, and even among those from ancient strata. This is a convenience only; it indicates that certain fossils present the general appearance of the existing genera to which they are referred; but in the majority of instances it does not prove that they would be so referred if the remains were in the same condition as the recent materials. In most cases we think it would be otherwise.

The substance of this pamphlet originally appeared as a series of introductory papers in vols. xv. and xvi. of the *Entomologists' Monthly Magazine*, but the reprint contains additional matter.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Opportunities of Science Masters at Schools

IN consequence of my publishing in your columns some facts on visual and other memory, I have been favoured with letters from many persons and from many countries; few however have been more acceptable than those from the masters and mistresses of schools. Confining my remarks for the present to the masters of the larger establishments, I may mention that the science masters of Cheltenham and of Winchester have promised assistance, but I write especially to acknowledge the aid already rendered to me by Mr. W. H. Poole, the science master of Charterhouse, and to make some comments thereon, in order to show how wide and yet how neglected a field for original research lies open to every schoolmaster. Mr. Poole has sent me returns from all the boys who attended his classes—172 in number. He selected certain of my questions concerning visual and other memory, he explained them clearly to the boys and interested them in the subject, and then he set them the questions to answer in writing, just as he would have set questions in the ordinary course of school-work. Lastly, he forwarded to me the replies in separate bundles corresponding to the different classes, and each paper was numbered, so that if I wanted to learn more about any of them and sent him the numbers, he

could ascertain the names of the writers. In this simple manner, by almost a single stroke, Mr. Poole has called a mass of statistical data into existence, more thorough and complete than could perhaps have been procured in any other way. I have spent many hours in analysing the answers, and find that they bear generally the marks of painstaking and veracity; they have already led me to results which appear important, but of which this is not the time to speak.

The observation I desire to make is that as every hospital fulfils two purposes, the primary one of relieving the sick, and the secondary one of advancing pathology, so every school might be made not only to fulfil the primary purpose of educating boys, but also that of advancing many branches of anthropology. The object of schools should be not only to educate, but also to promote directly and indirectly the science of education.

It is astonishing how little has been done by the schoolmasters of our great public schools in this direction, notwithstanding their enviable opportunities. I know absolutely of no work written by one of them in which his experiences are classified in the same scientific spirit as hospital cases are by a physician, or as other facts are by the scientific man in whose special line of inquiry they lie. Yet the routine of school work is a daily course of examination. There, if anywhere, the art of putting questions and the practice of answering them is developed to its highest known perfection. In no other place are persons so incessantly and for so long a time under close inspection. Nowhere else are the conditions of antecedents, age, and present occupation so alike as in the boys of the same form. Schools are almost ideally perfect places for statistical inquiries. If a census on other subjects such as this that has been made by Mr. Poole, was carried out, say once a term, or even once a year, at each great public school, what a rich statistical output we should annually witness. Or again, if a schoolmaster were now and then found capable and willing to codify in a scientific manner his large experiences of boys, to compare their various moral and intellectual qualities, to classify their natural temperaments, and generally to describe them as a naturalist would describe the fauna of some new land, what excellent psychological work might be accomplished! But all these great opportunities lie neglected. The masters come and go, their experiences are lost, or almost so, and the incidents on which they were founded are forgotten, instead of being stored and rendered accessible to their successors; thus our great schools are like mediæval hospitals, where case-taking was unknown, where pathological collections were never dreamt of, and where in consequence the art of healing made slow and uncertain advance.

Some schoolmaster may put the inquiry, What are the subjects fitted for investigation in schools? I can only reply, Take any book that bears on psychology, select any subject concerning the intellect, emotions, or senses in which you may feel an interest; think how a knowledge of it might best be advanced either by statistical questioning or by any other kind of observation, consult with others, plan carefully a mode of procedure that shall be as simple as the case admits, then take the inquiry in hand and carry it through.

FRANCIS GALTON

Museum Conference

PRESUMING that the object of a museum is twofold, viz., to instruct the general public through the eye and to serve as a repository of material by means of which specialists can carry on their scientific and historical researches, it must be obvious to every thoughtful observer how inadequate the machinery generally is to the end in view. A visitor, let us suppose, to the zoological department of a museum, observes a number of birds bearing a general family likeness, and a name under each specimen. Having no pictorial clue to the habits, native country, or specific distinctions of the numerous specimens, no verbal description before him, and no intelligent curator on the spot to give the information required, he goes away with a hazy impression of what he has seen, and too often with a headache. Surely there is room for improvement in the direction of the amount of information that could be conveyed by proper adjuncts to the specimens, and by grouping them according to the countries to which they belong, &c.? Many a missionary going abroad would gladly learn something of the economical and medicinal products of the country to which he is going; but in a museum in which vegetable products are grouped according to their natural orders his difficulties are increased tenfold. I can imagine no better means of improving the character of museums and of increasing their usefulness than a conference of curators to exchange ideas and the results of their experience. With regard to the use of musems by those seeking special information, the circumstances are very different in large cities and in small towns. In cities, as a rule, the curator naturally becomes in time the depository of a large amount of special information, for which there is such a demand that time is rarely left him for the manual labour and supervision which the keeping of a museum in good order involves. In this case it is assistance that is required rather than increase of salary, although a curator should in my opinion be so well paid that he need not be obliged to resort to literary work to eke out a living.

In provincial towns the case is somewhat different. The curator has less demand made upon his time by specialists, but he needs to be well acquainted with almost every branch of art and natural history, and is often expected to be able to lecture upon any subject that can at all be included within the range of objects in the museum. Such extensive knowledge is rarely to be found concentrated in one person, and consequently one branch of natural history is often pursued to the exclusion of others, as of arts and antiquities, or *vice versâ*; and it is little consolation to the naturalist who has done good local work to think that if his collection be left to the local museum it may become devoured by insects or neglected by a subsequent curator who takes little or no interest in that particular branch.

A monthly or quarterly publication would form an excellent means of communication for the exchange of duplicates, the distribution to suitable quarters of the productions of foreign countries for purposes of investigation, for the record of improvements in manipulation or exhibition, and for the results of experience in various directions. Such a publication, if circulated abroad, might be made the means of incalculable benefit to trade by suggesting uses for little known native productions and by bringing residents abroad in communication with those at home who could direct them how best to utilise the resources of newly-explored districts.

I see no reason also why museums, especially those of a technical character, should not be made in some degree self-supporting, by charging a small admission fee to visitors and a fixed fee for the identification of objects used or to be used in trade. I trust the subject of a museum conference will be well ventilated in your columns, and that the liberal offer of the Council of the Society of Arts will soon be turned to account by a preliminary meeting in the rooms of that Society. I would suggest that those who are able and willing to form an executive committee should forward their names at once to Mr. Paton, who will then be in a position to carry out a scheme which cannot fail to produce a beneficial effect upon the education of the nation at large.

E. M. HOLMES

Ural Crayfish

REFERRING to the notice in NATURE, vol. xxi. p. 454, of M. Malakhoff's memoir on Ural Crayfish, you will perhaps allow me, a resident among the foot-hills of the South-Western Urals, space for a few words. *Astacus leptodactylus* is found in most of the streams here, in some abundantly. The variety is that in which the cephalo-thorax and chelæ are studded with tubercles, and is accurately represented in Prof. E. Ray Lankester's Fig. 2, in NATURE, vol. xxi. p. 354. I have one before me at the present moment from a tributary of the River Bielaia, measuring five inches in length, and this is the average size. I have never seen the mountain variety mentioned in M. Malakhoff's paper. His remark that "in the Ural the natives call the freshwater Unio *Rak* (*Ecrevisse*) and the true crayfish *Rak-ryba* (*l'Ecrevisse poisson*)" does not apply to this district, for here the latter is called simply "*rak*" and the unio "rakovitza" and "rakovina" indifferently, general terms for a mullusc and its shell. Various opinions exist in reference to the quality of the flesh. For my own part I find it extremely insipid, and I believe any Englishman eating it for the first time would be of the same opinion; but the inhabitants of the country, who have, of course, no opportunity of tasting fresh marine crustacea, rather esteem the flesh. Englishmen staying here a long time often grow to like it in default of anything better, till I verily believe in some cases they leave the country praising it as a delicacy. This may be one of the ways in which the diverging opinions respecting its quality have originated.

W. H. TWELVETREES

Voskresensky Zavod, near Orenburg, Russia,
March 27 (April 8)

Protection against Mosquitos, Flies, and Blight

MR. HAGEN's letter on the destruction of insect-pests (NATURE, vol. xxi. p. 611) induces me to make generally known an absolute preventive of the bites of mosquitos, gnats, of green-fly in the vinery, blight in the garden, and a protection to animals from these "insect-pests." A few years ago I had some peach-trees which, being on a wall exposed to draught, were annually blighted. One died, and the new wood of the others was not more than a hand's length. A scientific friend advised me to try a weak solution of quassia to water them with, and the success was complete. Blight was prevented. The first year the trees bore well and the new wood was elbow-length or more. I next tried quassia in the vinery. Instead of lime-washing the walls to get rid of the green-fly, one watering with quassia dismissed them in a day. My head-gardener, who had previously much experience in nursery-grounds, wondered that he had never heard of it before. He now uses it in all cases as a protection from flies and blight. The dilution goes a long way: one pound of chips of quassia-wood boiled and reboiled in other water until he has eight gallons of the extract for his garden-engine. He finds it inadvisable to use it stronger for some plants. This boiling makes the quassia adhesive, and being principally applied to the underleaf, because most blight settles there, it is not readily washed off by rain. Quassia is used in medicine as a powerful tonic, and the chips are sold by chemists at from sixpence to a shilling a pound. The tree is indigenous to the West Indies and to South America.

And now as to gnats and mosquitos. A young friend of mine, severely bitten by mosquitos and unwilling to be seen so disfigured, sent for quassia-chips and had boiling water poured upon them. At night, after washing, she dipped her hands into the quassia water and left it to dry on her face. This was a perfect protection, and continued to be so whenever applied. The pastilles sold in Florence and elsewhere, which are vaunted to be safeguards against mosquitos, are, from my own experience, of no use.

At the approach of winter, when flies and gnats get into houses and sometimes bite venomously, a grandchild of mine, eighteen months old, was thus attacked. I gave the nurse some of my weak solution of quassia to be left to dry on his face, and he was not bitten again. It is innocuous to children, and it may be a protection also against bed insects, which I have not had the opportunity of trying. When the solution of quassia is strong it is well known to be an active fly-poison, and is mixed with sugar to attract flies, but this is not strong enough to kill at once. If it be true that mosquitos have been imported into one of the great hotels in the south-west of London, it might be very useful to anoint some of the furniture with it. Then a strong solution with sugar set about the rooms ought to clear them out.

Oatlands Park, Weybridge WM. CHAPPELL

Immersion of Iron and Steel in Acidulated Water

IN NATURE, vol. xxi. p. 602, I have read an interesting account of Prof. Hughes's experiments on the change produced in iron and steel wire by immersion in acidulated water.

May I ask you to draw the Professor's attention to my experiments on this subject, *vide Proceedings* of the Literary and Philosophical Society of Manchester, January 7, March 4, December 30, 1873; January 13, March 10 and 24, 1874; and *Proceedings* of the Royal Society, No. 158, 1875; and a short article in NATURE, I think.

It has long been known to manufacturers of iron wire that iron becomes brittle after immersion in dilute sulphuric or hydrochloric acids. I believe, however, that I was the first to show that this change was due to occluded hydrogen, and by a careful series of experiments to determine approximately the percentage alteration in the breaking strain and elongation at the moment of rupture produced by occluded hydrogen in—

(*a*) Ordinary or puddled iron wire;
(*b*) Iron wire manufactured with charcoal instead of coal;
(*c*) Mild or Bessemer steel;
(*d*) Cast steel.

I also found an increased electrical resistance in wire containing occluded hydrogen, though subsequent experiments have led me to believe that the numbers I first published were too large.

My papers also called attention to the diffusion of hydrogen in iron wire beyond the part immersed in acidulated water; the increase in the length of wire charged with hydrogen and some other phenomena.

The whole subject of the occlusion of hydrogen by metals is one of great interest, and the scientific world will be glad if an accomplished experimenter like Prof. Hughes turns his attention to the subject. WILLIAM H. JOHNSON

The Ferns, Bowdon, near Manchester, April 26

Stone Arrow Heads

THE interesting investigations of Mr. Redding on the method of making the above objects, as referred to in NATURE, vol. xxi. p. 613, have been somewhat anticipated by Mr. Paul Schumacher, "Methods of making stone weapons," *Bull.* U.S. Geol. and Geog. Survey, vol. iii. p. 547, 1877, which again was a translation from an earlier publication in *Archiv für Anthropologie*, vol. vii. p. 263. Mr. Schumacher's information was derived from the last arrow-maker of a tribe of Klamath Indians, and appears to correspond generally with that obtained by Mr. Redding from the representative of another tribe in the same region. Mr. Schumacher states that obsidian is not the only stone used, but chert, chalcedony, jasper, agate, and similar stones of conchoidal fracture. "The rock is first exposed to fire, and, after a thorough heating, rapidly cooled off, when it flakes readily into sherds of different sizes under well-directed blows at its cleavage." The process is also illustrated in Mr. Schumacher's paper. Superior stone mortars are often found in use amongst these Californian Indians, who deny their capability of making such objects, and account for their possession as "finds" either on the surface or beneath the earth, and describe them as the work of another and previous race.

W. L. DISTANT

Derwent Grove, East Dulwich, May 1

The Mode of Suckling of the Elephant Calf

IN some of the accounts recently published of the birth of an elephant in a menagerie in America it is stated that up to this time naturalists had always believed that the elephant calf obtained its mother's milk by means of its trunk, and not directly by the mouth.

Whether this be the case or not, Aristotle was certainly an exception, as the following passage from the twenty-seventh chapter of the sixth book of his "Historia Animalium" (Ed. Bekker, Oxford, 1837) clearly proves—'Ο δὲ σκύμνος, ὅταν γένηται, θηλάζει τῷ στόματι, οὐ τῷ μυκτῆρι, καὶ βαδίζει καὶ βλέπει εὐθὺς γεννηθείς.—"And the calf, when it is born, sucks with its mouth and not with its trunk; and it both walks and sees as soon as it is born." J. C. G.

May 3

The Tay Bridge Inquiry

IN the *Pall Mall* of April 21 appeared a report of the evidence of Mr. Henry Law, C.E., in the Tay Bridge inquiry. In this report Mr. Law is made to say: "The heavy girders would fall more rapidly than the carriages; a train moving forward at a great speed would not fall so rapidly as a quiescent structure."

I have been induced to ask your insertion of this note in NATURE in the hope that some of your readers who are at home in such matters may confirm or contradict these statements. A person with a mere elementary knowledge of dynamics would disbelieve the latter of them, and would doubt that the former has any *practical* truth. Q. C.

Queenwood College, near Stockbridge, Hants

Yeast and Black Beetles

IN what form should yeast be applied for the destruction of black beetles? If Prof. Lankester will show us how to exterminate them he will earn the gratitude of every

LONDON HOUSEHOLDER

27, Marlborough Hill, N.W., May 1

SUEZ CANAL ROCK SALT.—Dr. Ralton wishes to know where information can be obtained on the subject of the rock salt beds which were cut through in constructing the Suez Canal.

SODIC CHLORIDE CRYSTALS.—Dr. Ralton asks, what is the action of urea in modifying the crystal form of sodic chloride crystals, referred to by our reviewer of Dr. Ord's book?

[Sodium chloride usually crystallises in *cubes*; it is stated, however, by Prof. Maskelyne in a lecture before the Royal

Institution that in presence of uric acid it crystallises in *octahedra*. There are other similar facts: thus alum usually crystallises in *octahedra*; but if sulphate of alumina is present in excess the alum crystallises in *cubes*.]

THE SONGS OF BIRDS.—In Pennant's "British Zoology," vol. ii., Mr. C. C. Starling will find in an appendix a very interesting paper by the Hon. Daines Barrington on the singing of birds. The paper is dated 1773, and published in the *Philosophical Transactions*, vol. lxiii.—JAMES MACFADZEAN.

DECAISNE AND BAILLON[1]

IT is perhaps now time to make a protest against a scandal which has in no small degree excited the disgust of scientific men in various parts of Europe, who, like ourselves, have been favoured with copies of the privately-circulated publication of which the name stands at the foot of this note. That scientific men should quarrel, and quarrel sometimes with singular bitterness, is only to affirm in other terms that they are not exempt from the ordinary frailties of human nature. That they should make blunders in their work, however conscientiously performed, is but another illustration of the same truth. But that a scientific man with any respect for his calling should not merely think it worth while to publish the errors of one who has long laboured, and on the whole laboured not ingloriously, under the same roof as himself, and in the same pursuits, and should persist in the unhandsome enterprise of seeking out and raking together faults, even the most microscopic and frivolous, with all the relish and vindictiveness of gratified spite, is a thing so wholly disgusting that a protest should be made against it in the interest of common decency. Decaisne has spent a laborious life in botanical work of great usefulness and excellence, and his scientific reputation has long been established and acknowledged by his contemporaries, who have been quite capable of estimating the value of what he has done. Baillon, a much younger man, is scarcely less regarded for the industrious profusion and frequent originality of his botanical publications. But he will not materially affect the position of Decaisne by his animadversions, and it is pitiful that any portion of his abounding energy should be devoted to the attempt to discredit writings which, after all, will always be consulted by students on their own merits, and having regard to the state of knowledge at the time they were published. The fact is that no scientific man could undergo with credit such a scathing revision as that to which Baillon has subjected his unfortunate fellow-*savant*, and we do not say without some reason that the last person who would emerge from the process with anything like satisfaction would be Prof. Baillon himself.

DR. RUDOLF SCHEFFER

IT is with sincere regret that we have to record the sudden death of Dr. Rudolf H. C. C. Scheffer, the director of the Botanical Gardens, Buitenzorg, Java, which took place at Sindanglaya on March 9. The loss of Dr. Scheffer will be felt by a large circle of botanists throughout the world, for the splendid gardens of which he was superintendent were in communication with every home and colonial botanical institution; but in the Netherlands Indian Colonies, however, it is that his death will be most felt and deplored.

It is now some twelve years since Dr. Scheffer came out from Holland to take the first directorship of the gardens, which had come into high repute by the great number and variety of species collected into it by numerous eminent botanists and by the energy and zeal of its well-known *hortulanus*, J. E. Teysmann, who has by his numerous voyages added so many new species to the East Indian flora, and on the fiftieth anniversary of whose uninterrupted connection with the gardens Dr. Scheffer took so warm and active a part last January. Soon after his arrival Dr. Scheffer instituted a school for the training of native boys in the science of agriculture; and for their practical instruction he was the means of having an agricultural garden opened at Zjikoemah, close to the school, and some two miles from Buitenzorg. In this school Dr. Scheffer took the very highest interest and pleasure. It was not intended, on its institution, that he should take any active teaching duties, his superintendence was considered to be all that he could well bestow on it; but finding that the teaching staff was insufficient, he squeezed out of his already overburdened time several hours every day to devote to the tuition of these native boys. When on February 9, on his departure on a botanical journey to the south coast of Java, the writer, little thinking he was saying farewell for the last time, took leave of Dr. Scheffer, seemingly in his ordinary health, he received from him, to aid him in his work, a native boy who had lately taken his diploma of proficiency in the agricultural school. This boy was found to be well acquainted with the general flora of the district and with the classification of plants; he could accurately describe their organs and functions and state their economic uses; he had a good idea of the methods of fertilisation and the values of self- and cross-breeding. He was fairly grounded in the rudiments of zoology, anatomy, and physiology. Until he had tested this youth the writer did not believe it possible for the Malay mind to so clearly comprehend and so accurately to arrange scientific facts. In this the great power of Dr. Scheffer as a teacher appears, especially when it is remembered that he lectured almost to virgin minds and in a language so devoid of all precise and accurate terms as Malay. I am told by a friend, a competent botanist, who has listened to his lectures, that Dr. Scheffer's power of lucid explanation was very great. "I wish," he said, "I had had as good a course of lectures on botany in Holland."

In addition to the labour and anxiety attaching to this section of his work, Dr. Scheffer had also to give occasional lectures to the *aspirant controlleurs*, the young unplaced civil servants, and to superintend their examinations in agriculture. Over and above this he had the general superintendence of the large botanical gardens on his shoulders, with daily arrivals and despatches of plants to and from all quarters of the globe, on which he had to be consulted daily. If one had entered his small study in the fine building containing the herbarium, one would have found him engaged in his own peculiar work, in which he took so much delight, with his microscope and camera lucida studying the *Hemeleia vastatrix*, a subject to which he had been lately devoting much time; in another corner would be a series of Palms—part of Dr. Beccari's collection, on whose examination and description he was engaged, the sectional coloured drawings being done by one of his own native pupils. If we did not find him here we should see the microscope and pencil conveniently left so as to resume work at the shortest possible notice; and adjourning to his house, near the entrance to the gardens, we should certainly find him in his neat library surrounded by a diverse collection of botanical works, and with the spare corners decorated with the busts and photographs of distinguished botanists, with an enormous pile of correspondence, to which he was writing heads of reply in Dutch, French, English, German, for his amanuensis. Dr. Scheffer told the writer that he wrote more than 3,000 letters a year with his own hand. He corresponded with every country and every botanical garden in the world; he had to give all sorts of advice to agriculturists throughout the Archipelago, on the cultivation of or the diseases affecting coffee, tea, sugar, tobacco, &c., and the many great improvements effected in the production of these valuable products is

[1] "Errorum Decaisneanorum graviorum vel minus cognitorum centuria quinta, Auctore H. Baillon."

due in a great measure to his advice. Need we wonder, then, even with youth in his favour, that at the early age of about thirty-seven, being yoked in such heavy double harness, he has died with it on, leaving a large amount of accomplished valuable work, which was waiting for a spare moment to prepare for the publisher.

For some time Dr. Scheffer had been suffering from defective digestive powers and frequent sleeplessness, but he neglected these warnings and the advice of his friends to take some rest. He was unfortunate in being surrounded by those who, with few exceptions, took little interest in his work, and by none to whom he thought he could entrust the work in which he was so hard and enthusiastic a worker, so he worked on. The fatal affection was inflammation of the liver. The seizure was very acute, and at an early stage danger was imminent; but at length he rallied. His medical attendants considered the crisis past, and recommended his removal to his own estate near Sindanglaya, to reach which a tedious climb of 4,500 feet over the Megameudoeng Pass had to be surmounted. He never reached his destination, expiring, on March 9, at the Sanatorium at Sindanglaya, where he now lies buried.

In his private life he was a man to be loved and esteemed; quiet, unassuming, very kind-hearted, ever ready to give whatever assistance he could, especially to scientific travellers. With him the Netherlands Indian Government has lost a valued public servant, to whom it will not be easy to find a successor, and botanical science has to deplore an earnest worker, a learned disciple, and a great helper. HENRY O. FORBES

Preanger, Java

A SCOTTISH CRANNOG[1]

BETWEEN geology and history there lies an intermediate sphere in which these sciences dovetail into one another. In this common territory or borderland lies the domain of prehistoric archæology, and to its most recent portion, or that which archæologists have designated the "Late Celtic Period," must be assigned the antiquarian remains I have here the pleasure of describing. During this period it appears that the Celtic races of Scotland and Ireland were in the habit of constructing artificial islands in marshes and shallow lakes to which, in troublous times, they resorted for safety. They were generally formed by the superposition of trunks of trees and brushwood mingled with stones strongly palisaded by stakes, and so situated as to be inaccessible except by means of causeways, or occasionally by a narrow gangway or mole. These island forts, or *crannogs*, as they have been called in the Irish annals, were very numerous in former times, but owing to the gradual rising of the level of the lakes, they appear to have been so completely lost sight of that their very existence was unknown to modern antiquaries, so that their discovery in the present century marks an important epoch in the history of archæology.

In October, 1878, I drew the attention of antiquaries, through the columns of NATURE, to the remains of an ancient lake-dwelling just then discovered on the farm of Lochlee, in the parish of Torbolton, Ayrshire. Since then a series of excavations have been made with the view of ascertaining the exact nature of this structure, in the course of which a large collection of most interesting relics has been made.

In the year 1839, while a small lake on this farm was being artificially dried up for agricultural purposes, the attention of the labourers was directed to a singular mound, in which, on cutting drains through it, they exposed some wrought wood-work; but their observations, though freely talked of in the neighbourhood at the time, led to no further results till forty years later, when it was found necessary to re-drain the locality, and hence the present investigations. By a curious coincidence the early drainage at Lochlee was made in the same year that Sir W. R. Wilde discovered and examined the first Irish crannog, viz., that of Lagore in County Meath. The Irish discovery, however, owing to a general system of drainage that was then going on, led at once to the most brilliant results, so that it soon became apparent that crannogs existed very generally over the country. Up to the present time over a hundred have been examined, and have furnished the Irish museums with a vast collection of relics. In the year 1854 a great impetus was given to the study of these researches by the discovery of the remains of ancient lake villages in Switzerland, which have now become so famous and well known all over the continent of Europe; but it was not till 1857 that the subject began to attract the attention of Scottish archæologists. In this year Mr. Joseph Robertson read a paper to the Society of Antiquaries of Scotland, and in 1866 Dr. Stuart, who was then Secretary to this Society, collected and published all the scattered notices of Scottish crannogs known up to that date. Since the publication of Dr. Stuart's elaborate paper no further investigations on Scottish crannogs, with the exception of an occasional notice of a fresh discovery of the site of one, have been recorded.

But though traces of these crannogs have been found in almost every county of Scotland, there has been no systematic examination of them worthy of comparison with the investigations that have been made in other countries; nor, with the exception of a few articles found at Dowalton, is there any collection of relics which would enable archæologists to form an opinion with much certainty as to the purpose they served in the social economy of the period they represent; nor can their range in the dim vista of prehistoric times be determined with greater accuracy.

Before the Lochlee Lake was originally drained no one appears to have surmised that a small island (visible only in the summer time) which formed a safe habitation for gulls and other sea-birds during the breeding season, was formerly the residence of man. It was situated near the outlet of the lake-basin, and the nearest land, its southern bank, was about seventy-five yards distant. The general appearance which it presented when the present investigations were commenced was that of a grassy knoll, drier, firmer, and slightly more elevated than the surrounding field. Towards the circumference of this mound the tops of a few piles were observed barely projecting above the grass. Guided by these the workmen dug a deep circular trench, in which they exposed numerous piles and transverse beams having square-cut holes in their ends, through which the former projected about eighteen inches or two feet. In the course of further explorations it became apparent that these piles formed a series of stockades surrounding a somewhat circular space about fifty feet in diameter. Beyond this circle on the south side there were indications of other rows of uprights which appeared to unite into one on the north side. Here, instead of further rows of piles, the corresponding space was occupied by an intricate arrangement of woodwork, consisting of young trees and stout branches, mixed with slanting stakes and logs running in all directions, the whole forming a dense protective barrier. The diameter of the island was about 120 feet. The central area was about three feet lower than the surrounding stockades with their transverses, and had a flooring of prepared logs resembling railway sleepers. Near the centre of this log pavement were found four circular hearths placed one above the other with an interval between each of 18 inches to $2\frac{1}{2}$ feet. These hearths were neatly constructed of flat stones of various

[1] A full report of the Lochlee Crannog is given in vol. xiii. of the *Proceedings* of the Society of Antiquaries of Scotland, and in vol. ii. of the Collections of the Ayrshire and Wigtownshire Archæological Association.

sizes, and had a raised rim round them, also formed of flat stones, but uniformly selected and set on edge. Each of them was imbedded in a thin layer of clay, which extended several feet beyond, and the intermediate strata consisted of ashes, charcoal, and small bits of burnt bones. The top of the upper hearth was 7 feet 9 inches above the log pavement, but only about one foot below the surface of the mound, so that the greatest depth of the accumulated rubbish since the log pavement was laid would be about 8½ feet. The lowest or first fireplace was separated from the log pavement by a thick layer of turf and then a layer of clay.

On a level with the third hearth, counting from below, there were decayed portions of several massive stakes, with square-cut ends which appeared to have been the remains of a hut. One stake was found to have a small portion projecting from the centre of its base, which neatly mortised into a hole formed by a piece of wood, a flat stone, and some clay, and another had pressed down the portion of clay on which it rested nearly a foot. It was thus evident that the stakes were so formed as to prevent them as much as possible from sinking by pressure. Immediately below this level, all over the area of the log-pavement, but more particularly within a circle a few feet from the fireplace, most of the relics were found. Close to this hearth, but about two feet lower, we extracted the skeleton of an animal like that of a goat or sheep, the skull of which was entire, and had short horn-cores attached to it. The relic bed was made up of partially decomposed vegetable matters, and could be separated into thin layers; the common bracken, moss, parts of the stems of coarse grass, heather, and large quantities of the broken shells of hazel-nuts were frequently met with. One of the latter was found to have a hole gnawed in it, as if made by a squirrel.

The space immediately beyond and on the south side of the log pavement, extending between it and the outer circles of piles, was occupied by a refuse heap or midden, consisting of gritty ash, decayed bones, and vegetable matters. Its breadth was ten or twelve feet, and its length from east to west nearly double that. Its surface was three feet below that of the field, so that its average depth would be about four feet. Some important relics were found here, such as metal instruments and daggers, two fibulæ, several wooden vessels, and a few bone implements. It is noteworthy that the metal objects were all comparatively near the surface of the midden, and also that no boars' tusks were found in it except at its very lowest stratum.

The probable existence of some kind of communication between the crannog and the shore of the lake was suggested at an early stage of the investigations by the discovery of a few oak piles in a drain outside the mound on its south side. Upon making excavations in the line thus indicated a very singular wooden structure was discovered, which I found no less difficult to comprehend than it now is to describe. The tops of upright stakes were first revealed, which seemed to conform to no regular arrangement, but by and by, in addition to single piles, groups of three, four, and five, here and there, were detected. The first horizontal beam was reached 7 feet below the surface of the field, which proved to be one of a complete network of similar beams lying in various directions. At a depth of 10 feet the workmen could find no more horizontal beams, and the lake silt became harder and more friable. The reason of grouping the piles now became apparent. The groups were placed in a somewhat zigzig fashion near the sides of the gangway, and from each there radiated a series of horizontal beams, the ends of which crossed each other and were kept in position by the uprights. One group was carefully inspected. The first or lowest beam was right across; the next lay lengthways, and of course at right angles to the former; then three or four spread out diagonally, like a fan, and terminated in other groups at the opposite side of the gangway; and, lastly, one again lay lengthways. Thus each beam raised the level of the general structure the exact height of its thickness, though large lozenge-shaped spaces remained in the middle quite clear of any beams. The general breadth of the portion of this unique structure examined was about 10 feet, and its thickness varied from 3 to 4 feet. A large oak plank, 10 feet long, showing the marks of a sharp cutting instrument by which it was formed, was found lying on edge at its west side and beyond the line of piles, but otherwise no remains of a platform were seen. All the beams and stakes were made of oak, and so thoroughly bound together that, though not a single joint, mortise, or pin was discovered, the whole fabric was as firm as a rock. No relics were found in any of the excavations along the line of this gangway.

The thickness, composition, and mode of structure of the island itself was ascertained by sinking a shaft at the south end of the log pavement (*i.e.*, near the centre of the island). This shaft was rectangular in form, and large enough to allow three men to work in it together. After removing the three or four layers of oak planks which constituted the log pavement, we came upon a thin layer of brushwood, and then large trunks of trees laid in regular beds or layers, each layer having its logs lying parallel to each other, but transversely and sometimes obliquely to those of the layer immediately above or below it. At the west end of the trench, after removing the first and second layers of the log pavement, we found part of a small canoe hollowed out of an oak trunk. This portion was 5 feet long, 12 inches deep, and 14 inches broad at the stern, but widened towards the broken end, where its breadth was 19 inches. This was evidently part of an old worn-out canoe, thus economised and used instead of a prepared log. Much progress in this kind of excavation was by no means an easy task, as it was necessary to keep two men constantly pumping the water which copiously flowed from all directions into the trench and even then there always remained some at the bottom. As we advanced downwards we encountered layer upon layer of the trunks of trees with the branches closely chopped off, and so soft that the spade easily cut through them. Birch was the prevailing kind of wood, but occasionally beams of oak were found, with holes at their extremities, through which pins of oak penetrated into other holes in the logs beneath. One such pin, some 3 or 4 inches in diameter, was found to pass through no less than four beams in successive layers, and to terminate ultimately in a round trunk over 13 inches in diameter. One of the oak beams was extracted entire, and measured 8 feet 3 inches in length and 10 inches in breadth, and the holes in it were 5 feet apart. Others were found to have small round projections, which evidently fitted into mortised holes in adjacent beams. Down to a depth of about 4 feet the logs were rudely split, but below this they appeared to be round rough trunks, with the bark still adhering to them. Their average diameter would be from 6 inches to 1 foot, and amongst them were some curiously gnarled stems occasionally displaying large knotty protuberances. Of course the wood in the act of digging the trench was cut up into fragments, and, on being uncovered, its tissues had a natural and even fresh-like appearance, but in a few minutes after exposure to the air they became as black as ink. Amongst the *débris* thrown up from a depth of 6 feet below the log pavement I picked up the larger portion of a broken hammer-stone or polisher, which, from the worn appearance presented by its fractured edges, must have been used subsequently to its breakage. After a long and hard day's work we reached a depth of 7 feet 4 inches, but yet there were no indications of approaching the bottom of this subaqueous fabric. However, towards the close of the second day's labour, when the probability

of total discomfiture in reaching the bottom was freely talked of, our most energetic foreman announced, after cutting through a large flat trunk 14 inches thick, that underneath this he could find no trace of further woodwork. The substance removed from below the lowest logs consisted of a few twigs of hazel brushwood, imbedded in a dark, firm, but friable, and somewhat peaty soil, which we concluded to be the silt of the lake deposited before the foundations of the crannog were laid. The depth of this solid mass of woodwork, measuring from the surface of the log pavement, was 9 feet 10 inches, or about 16 feet from the surface of the field. Amongst the very last spadefuls pitched from this depth was found nearly one-half of a well-formed and polished ring made out of shale, the external and internal diameters of which were 3½ and 2 inches respectively.

In all the trenches made at the margin and beyond the crannog the stuff dug up was of the same character and composition. First or uppermost there was a bed of fine clay rather more than 2 feet thick, and then a soft, dark substance formed of decomposed vegetable matters. The source of the latter was evident from the occurrence in its upper stratum of large quantities of leaves, stems, branches, and the roots of stunted trees apparently *in situ*. This uniformity in the composition of the silt forming the bed of the lake points to the fact that for centuries the increase was due principally to the decomposition of vegetable matters, while latterly it was caused more by a deposition of fine clay. A change so marked in the sediment can only be accounted for by a corresponding change in the surrounding scenery, and no explanation is more likely than that the primæval forests had given place to the inroads of agriculture, when some of the upturned virgin soil would be washed down, as it still is, by every trickling rill that finds its way into this lake basin.

The remains of human industry found during the excavations of the Lochlee Crannog, calculated to throw light on the civilisation and social economy of its occupiers, are very abundant. They comprise a large variety of objects, such as warlike weapons, industrial implements, and personal ornaments, made of stone, bone, horn, wood, metal, &c. In the following description of them I have adopted the principle of classification suggested by the materials of which they are composed :—

I.—*Objects made of Stone*

Hammer Stones.—A great many water-worn pebbles, of a similar character to those observed in the surrounding glacial drift and river courses, which were used as

FIG. 1.—Hammer-Stone (Scale ½).

hammers, pounders, or rubbers, were found in the *débris* all over the crannog, but more abundantly in the deeper layers of a small circular area surrounding the hearths. As typical specimens of such implements I have collected no less than nineteen. Of these fourteen are of a somewhat elongated oval shape, and were used at one or both ends (Fig. 1). They vary considerably in size, the major diameter of the largest measuring 6 inches, and the rest graduating downwards to about the half of this. Two are flat and circular, and show friction markings all round, while other three were used on their flat surfaces only. One of these is divided into two portions, each of which was picked up separately, about a yard asunder, and found to fit exactly. It would thus appear that it was broken while being used on the crannog, and then pitched aside as useless.

Heating-Stones and Sling-Stones.—A large number of round stones, varying in size from half an inch to three inches in diameter, some having their surfaces roughened and cracked as if by fire, but others presenting no marks whatever, were met with. The former might have been used as heating-stones for boiling water in wooden vessels—the only ones found on the crannog—the latter as sling-stones or missiles.

Anvil.—About a foot below the surface, and a few feet to the north of the upper fireplace, a beautiful quartz pebble was found, which has the appearance of having been used as an anvil. It is of a circular shape, flat

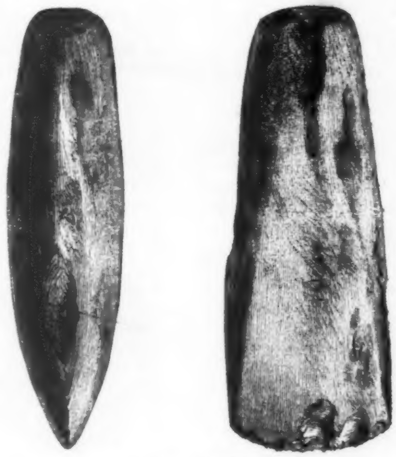

FIG. 2.—Stone Celt (Scale ½).

below, somewhat rounded above, and measures 27 inches in circumference.

Sharpening-Stones or Whetstones.—Five whetstones were collected from various parts of the island. They are made of a hard, smooth claystone, one only being made of a fine-grained sandstone, and vary in length from 5 to 7 inches.

Polished Celt.—Only one polished stone celt was found. It is a wedge-shaped instrument 5½ inches long and 2 broad along its cutting edge, which bears the evidence of having been well used, and tapers gently towards the other end, which is round and blunt. It is made of a hard mottled greenstone (Fig. 2.).

Querns.—Five upper, and portions of several lower quern stones were disinterred at different periods, all of which, however, with the exception of a pair found over the log pavement, and an upper stone observed towards the west margin of the crannog, were imbedded in the *débris* not far from the site of the fireplaces. Some are made of granite, while others are of schist or hard whinstone.

Cup-marked Stones.—Two portions of red sandstone, having cup-shaped cavities about 1 inch deep and 3 inches in diameter, were found amongst the *débris*. One of them was lying underneath, and as if supporting one of the horizontal raised beams at the north side of the

crannog. The other, the position of which was not determined, has two circular grooves or rings round the cup, the outer of which is 9 inches in diameter (Fig. 3).

FIG. 3.—Cup Stone (Scale $\frac{1}{4}$).

Other Stone Relics.—Amongst a variety of other stone relics there is one peculiar implement manufactured out of a bit of hard trap-rock. It presents two flat surfaces 3 inches in diameter, with a round periphery, and is $1\frac{3}{8}$ inch thick.

Flint implements.—Only three flint implements were found on the crannog—a large knife flake 3 inches long and $1\frac{1}{4}$ inch broad; the posterior portion of another flake; and a beautifully-chipped horseshoe-shaped scraper here figured (Fig. 4).

Spindle whorls.—Three small circular objects, supposed to be spindle whorls, are here classed together. Two are made of clay, and were found in the relic bed near the fireplaces. The smaller of the two (Fig. 5) is

FIG. 4.—Flint Scraper (Scale $\frac{1}{1}$).

FIG. 5.—Clay Spindle Whorl (Scale $\frac{1}{1}$).

$1\frac{1}{4}$ inch in diameter, and has a small round hole in the centre; the other has a diameter of $1\frac{3}{4}$ inch, and is only partially perforated, just sufficiently to indicate that the act of perforation had been commenced, but not completed. The third object is a smooth, flat, circular bit of stone, $1\frac{1}{2}$ inch in diameter and $\frac{1}{2}$ inch thick, and is perforated in the centre like a large bead.

(*To be continued.*)

NOTES

THE Royal Society of Edinburgh has awarded the Keith Medal for the biennial period 1877–79 to Prof. Fleeming Jenkin for his paper on the application of graphic methods to the determination of the efficiency of machinery.

PROF. HENRY J. S. SMITH, F.R.S., Savilian Professor of Geometry in the University of Oxford, has been made a Corresponding Member of the Academy of Science of Berlin.

ON the 16th inst. the International Congress of Meteorology will meet at Vienna.

THE honorary degree of LL.D. has been conferred by the University of Glasgow on Mr. Edward John Routh, M.A., F.R.S., and Dr. Michael Foster, F.R.S.

PROF. W. H. FLOWER, LL.D., F.R.S., will give a discourse at the Royal Institution, on Fashion in Deformity, at the evening meeting on Friday, May 7.

PROF. HUXLEY will deliver the inaugural address at the opening of the Science College at Birmingham on October 1.

SIR WILLIAM THOMSON will preside at the meeting of the Physical Society on Saturday afternoon, and will make some brief communications to the Society.

PROF. HENRY TANNER, F.C.S., Senior Member of the Royal Agricultural College, and Examiner in the Principles of Agriculture under the Government Department of Science, has been appointed Professor of the Principles of Agriculture in the Royal Agricultural College, Cirencester.

THE fifty-first anniversary meeting of the Zoological Society was held last week. The report of the council was read by Mr. Sclater, F.R.S., the secretary. It stated that the number of Fellows on December 31, 1879, was 3,364 against 3,415 at the same date of the previous year, 145 new Fellows having been elected, and 189 removed by death or other causes during the year. In consequence of the bad weather, which had seriously affected the garden receipts, and of the general depression in business which had prevailed in 1879, the income of the society showed a falling off as compared with that of 1878, but not to any serious amount; the total receipts having been 26,463*l.* in place of 27,944 in 1878. The total assets of the society on December 31 last were estimated at 28,051*l.*, and the liabilities at 9,960*l.* The number of visitors to the gardens in 1879 had been 643,000, against 706,713 in 1878.

THE general meeting of the German Geometrical Society will be held at Cassel on July 4-7 next.

IN the last week of April an extraordinary fact was observed at Montsouris. We have stated already that the electrical observations are taken eight times daily with a Thomson electrometer and recorded; out of the eight readings registered on April 28 not less than six were negative, and on the following day seven were of the same sign. The occurrence is so extraordinary that it has been referred to in the papers as a fair characteristic of the season.

A LARGE and influential committee of shipbuilders and marine engineers has been formed in Glasgow for the purpose of promoting an exhibition of naval and marine engineering models in Glasgow. It is proposed that the exhibition shall be opened in the Corporation Galleries in November and remain open for six months. Mr. James Paton, the Superintendent of the Glasgow Museum and Galleries, has been appointed Secretary to the Committee.

AT the next meeting of the Society of Telegraph Engineers Dr. Siemens is going to bring forward his latest development of his dynamo machine, and of the influence of the electric light on vegetation.

THE Whit-Monday excursion of the Geologists' Association will be to Oxford, under the direction of Prof. Prestwich and and Mr. James Parker. It will last over two days. The long excursion of the Association will be to Bristol on August 2 and following days.

FROM the Report of the New York Central Park Menagerie we learn that that establishment has now 423 mammals, representing 56 genera and 98 species; 753 birds, of 102 genera, 134 species; 30 reptiles, of 8 genera and 10 species; or 1,206 animals in all. The additions in 1879 numbered 668.

HEYWOOD of Manchester has issued, for the small price of sixpence, the eleventh series of the Manchester Science Lectures for the People, containing lectures on "Islands," by Mr. A. R. Wallace; "The Age of Dragons," by Mr. B. W. Hawkins; "Palestine in its Physical Aspects," by Canon Tristram; and

"Traps to Catch Sunbeams," by Capt. Abney. We are sorry to learn from Prof. Roscoe's preface that the interest in these lectures having died out, they are to be discontinued. Nevertheless, as he says, they have undoubtedly done great good both when delivered and in the remarkably cheap form in which they have been published. The series, as a whole, has been a genuine success.

WE understand that Dr. James Geikie, F.R.S., will shortly send to press a work entitled "Prehistoric Europe—a Geological Sketch," which treats of the principal climatic and geographical changes which have taken place in our continent since the commencement of the Pleistocene or Quaternary period. Mr. Stanford will be the publisher.

THE Council of the Society of Arts have decided to summon a public Conference to consider the question of supplying London with pure water. The date for the Conference has been fixed for Monday, May 24, and succeeding days. The arrangements for the Conference are now being considered by a committee, and full announcements will be made as early as possible.

SINCE November last, instruction by means of lectures and laboratory practice, in connection with the City and Guilds of London Institute for the Advancement of Technical Education, has been given during the evening in Chemistry and Physics as applied to the Arts and Manufactures, by Prof. Armstrong, Ph.D., F.R.S., and Prof. Ayrton, A.M. Inst. C.E., in rooms at the Cowper Street Schools, Finsbury. On and after May 10, day classes will also be established, adapted to the scientific requirements of persons partially engaged, or intending to engage, in the manufacturing industries. The object of these day classes is to afford such preliminary training as is necessary for those who may desire, later on, to study particular branches of Applied Chemistry or Physics, for which special accommodation will be provided in the new buildings. Two courses, each of twenty-four lectures, in Chemistry and Physics will be given on two afternoons per week during May, June, and July, for imparting such knowledge of the general principles as is necessary for the after-understanding of the various branches of Applied Chemistry and Physics:—Chemistry, Wednesdays and Fridays, at 3 to 4 o'clock; Physics, Wednesdays and Fridays, at 4 to 5 o'clock. Prof. Ayrton will also give a special laboratory and tutorial course in Electrical Engineering; and Prof Armstrong will give a similar course for instruction in Photographic Chemistry. Students desirous of attending either of these courses are requested to communicate with the respective Professors at the present temporary laboratories, Cowper Street, Finsbury, E.C., before May 10, stating the times at which they could attend, and the maximum number of hours they could devote to the subject.

WE learn from Catania, under date April 26, that the inhabitants were apprehending an eruption of Etna. An immense cloud of smoke has been observed.

A PARISIAN speculator has inaugurated the aëronautical season by a private ascent on April 25 at La Villette gasworks. The balloon, of only 300 cubic meters capacity, bore one aëronaut, with 30 kilograms of handbills, which were distributed all over Paris. The wind being slight, with a favourable direction, thousands of these prospectuses were picked up by street passengers and largely read. The whole expense of the aërial expedition, gas and everything, did not exceed 10*l.* sterling.

THE phylloxera has made its appearance in the vineyards on Vesuvius and the opposite part of the Gulf at Puzzuoli and Pianura. Much alarm prevails. Precautionary measures are being taken. In Sicily the phylloxera, till now confined to Caltanisetta, is likewise reported near Messina.

AT the Annual Meeting of the Royal Institution on May 1, the Annual Report of the Committee of Visitors for the year 1879, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The real and funded property now amounts to nearly 85,000*l.*, entirely derived from the contributions and donations of the Members. Forty-nine new Members paid their admission fees in 1879.

THE *Japan Gazette* states that the line of railway which has been in contemplation for some time past between Tokio and Mayebashi will soon be commenced. The surveys are completed, and it is said that the line will traverse a rich district, and is expected to prove a great benefit to the country.

AN exhibition of apparatus and products relating to bee-culture will be held at Schwerin on August 28-30 next.

THE Electrotechnical Society at Berlin, which was founded on December 20, 1879, begins the second quarter of its existence with no less than 1,248 members.

THE Emperor of Austria has presented the large gold medal "for arts and sciences" to Dr. Karl Ritter von Scherzer in recognition of his latest work, "Die britischen Welt-Industrien."

THE *Report* of the Rugby School Natural History Society for 1879 is fairly encouraging. Several creditable papers are given by the members; we should like to see more papers of this class and fewer lectures by grown-up outsiders, some of which seem to us quite inappropriate in a *Report* of this kind.

"THE International Dictionary for Naturalists and Sportsmen in English, French, and German," by Mr. Simpson-Baikie (Trübner and Co.), is a very useful book of reference, and contains a good many scientific terms, especially connected with natural history.

"THE Sportsman's Guide" to the rivers, lochs, moors, and deer forests of Scotland comes once more to remind us of the hills and the heather, and to recall the memory of pleasant days spent on loch and river. It bears evidence of careful revision, and we are sure will prove useful to the tourist of scientific tastes, even if he be no disciple of the rod or gun.

IT is known that M. Jamin, member of the French Institute, has patented an electric lamp in which the light is directed by an electrical current. A public company has been formed with a capital of 8,000,000 francs for the working of the patent.

THE French Minister of Fine Arts has entered into an agreement with the Jablochkoff Electric Light Company to light the palace during the whole of the two months devoted to the exhibition. The number of lights fed by the machinery is about 400, and the motive power regarded at about 320 horses. The inauguration was to take place on May 1, and a large crowd had congregated to witness the process. But the crank of one of the principal engines broke, and it was necessary to postpone the opening for a few days. In spite of the growing opposition of the friends of the gas company, M. Garnier, the architect of the Paris Opera, will establish a trial of the principal electrical burners, to decide which is the more really fit for use in the house.

THE additions to the Zoological Society's Gardens during the past week include a Common Ocelot (*Felis pardalis*) from South America, presented by Mr. Stephenson Clarke; two Elliot's Guinea Fowls (*Numida ellioti*) from East Africa, presented by the Rev. Thos. Wakefield; two American Barn Owls (*Strix flammea*) from Jamaica, presented by Mr. G. E. Dobson, C.M.Z.S.; a Koala (*Phascolarctus cinereus*) from South-East Australia, a Grey Squirrel (*Sciurus cinereus*) from North America, two Blue-streaked Lories (*Eos reticulata*) from Timor

Laut, two Prince Albert's Curassows (*Crax alberti*) from Columbia, purchased; two Common Foxes (*Canis vulpes*), four Chilian Pintails (*Dafila spinicauda*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

THE COMET OF 1106.—Amongst the comets which were thought to present certain indications of identity with the great comet of 1843 was that recorded by a large number of European historians, as well as in the Chinese Annals, in the year 1106. The circumstances of its appearance may be thus briefly stated: On the 4th of February, or, according to others, on the 5th, a star was seen which was distant from the sun "only a foot and a half"; it was observed from the third to the ninth hour of the day. Matthew Paris and Matthew of Westminster distinctly term it a comet. Pingré, not having the experience of the comet of 1843 as a precedent, questioned the possibility of seeing one of these bodies at so small a distance from the sun as the above expression may be taken to imply. Now, however, we are able to connect, with much probability, the star viewed in the day-time with the comet which on February 7 was discovered in Palestine about the commencement of the sign Pisces. On this day, we are told by three contemporary writers, a comet appeared in that quarter of the sky where the sun sets in winter, and occasioned great surprise; a white ray extended from it to a great distance. From the time of its first appearance "the comet itself and the ray, which had the whiteness of snow, diminished day by day." Others, on the contrary, say that the train, which had a more than milky whiteness, appeared to increase daily. In the west of Europe it does not seem to have been remarked till February 16 or 18. According to some writers it was visible only a fortnight, others say that it continued to shine for forty days, or during the whole of Lent, from February 7 to March 25; an eye-witness records that after fifty days the most acute vision only sufficed to distinguish it with difficulty. There is similar contradiction respecting the aspect of the comet, though most of the historians testify to its great brightness and apparent magnitude. On February 10, according to Gaubil's manuscript, used by Pingré for his "Cometographie," it was near the end of the sign Pisces, with a tail 60° in length. European chronicles mention that the tail extended to the beginning of the sign Gemini, under the constellation of Orion, whence, as Pingré points out, the latitude of the comet must have been south, while as the sun was in 25° of Aquarius, it could hardly be less advanced than 10° or 12° of Pisces to be seen in the evening after sunset. Thence, about February 16 or 18, it moved to the western quarter of the heavens, and after many days had elapsed, as Pingré records: "La comète parut du côté du septentrion vers l'occident: sa queue, semblable à une grand poutre, regardoit la partie du ciel qui est entre le septentrion et l'orient; on la voyoit jusque vers le milieu de la nuit. Durant vingt-cinq jours elle brilloit de la même manière à la même heure." Williams, in his account of comets mentioned in the Chinese annals, has a notice of the one in question. In the reign of Hwuy Tsung, the 5th year of the epoch Tsung Ning, the 1st moon, day Woo Seuh (1106, February 10), a comet appeared in the west. It was like a great Pei Kow (a kind of vessel or measure). It appeared like a broken-up star. It was 60 cubits in length and 3 cubits in breadth. Its direction was to the north-east: it passed the sidereal division Kwei (determined by β, δ, ϵ Andromedæ and stars in Pisces), and through the divisions Lew (determined by α, β, γ Arietis), Wei (by the three stars of Musca), Maou (by the Pleiades), and Peih (by α, γ, δ, &c., Tauri). It then entered the clouds and was no more seen. Williams, doubtless influenced by this last expression, and the object having been said to resemble a broken-up star, and probably overlooking the presence of the comet recorded by the European historians in the same part of the sky, adds: "This appears to have been a large meteor, as it seems to have been seen for a short time only." But there can be little hesitation, we think, in identifying the body remarked in China with the European comet, its track through the constellations, as given by Williams, which agrees with Gaubil's manuscript, representing very satisfactorily the particulars found in the European chronicles.

In 1843 Laugier and Mauvais, reducing their elements of the great comet of that year to 1106, and assuming the perihelion passage to have taken place on February 3, found the following geocentric track.

Feb.	4,	Long.	324°,	Lat.	−3°	Feb.	16,	Long.	4°,	Lat. −23°
	7,	,,	335,	,,	−10	March	5,	,,	40,	,, −28
	10,	,,	345,	,,	−16		25,	,,	60,	,, −27

And they conclude, "en admettant que la comète de 1106 est une apparition de la comète de 1843, toutes les observations sont satisfaites." It is not easy to see how such an inference can have been drawn in face of the circumstances mentioned by the historians during the later period of the comet's visibility, when it was seen to the north of west, with a tail extending towards *the north-east*; a condition wholly incompatible with the elements of the comet of 1843, which body did not remain on the northern side of the ecliptic so long as three hours. On reducing Hubbard's parabola of 1843 to 1106 we have the following positions, assuming perihelion passage February 3·5 G.M.T.:—

G.M.T.		h.	Long.	Lat.	Log. *r*.	Log. Δ.	Intensity of Light.
			°	°			
Feb.	4,	0 ...	322·9 ...	− 1·7 ...	8·8080 ...	9·9704 ...	277·6
	19,	8 ...	12·6 ...	−25·1 ...	9·8377 ...	9·9543 ...	2·6
March	25,	12 ...	60·3 ...	−27·3 ...	0·1725 ...	0·2619 ...	0·13

These places are in agreement with those found by Laugier and Mauvais; that for March 25 corresponds to R.A. 63°·7, Decl. −6°·4.

It is well known that the comet of 1106, with better reason, was long supposed to be identical with the famous comet of 1680. That point has been discussed elsewhere. Our object now, since the possibility of the identity of the comet of 1106 with that of 1880 and 1843 has been again mooted, is to draw attention to the main difficulty that exists in the acceptance of the idea.

PHYSICAL NOTES

M. ANTOINE BREGUET, at a lecture upon Recent Advances in Telegraphy, exhibited some ingenious apparatus illustrating the principles of the duplex and quadruplex telegraph, the actions of the electric currents being most successfully represented by the flow of water in tubes.

PROF. CARMICHAEL describes, in the *American Journal of Science*, a device for rendering the sonorous vibrations of a flame visible to a whole audience. He passes coal-gas through a König's manometric capsule, and then leads it by a tube into a burner inclosed in a small mica cylinder or lantern, which is rotated either in a vertical or a horizontal plane. The ring of light thus produced is broken up by the sonorous vibrations into a serrated form, the forms of the serrations varying with the nature of the sound. To increase the brilliance of the light the gas is previously passed over a sponge soaked in some volatile hydrocarbon such as "gasoline" or "benzoline," and oxygen is also supplied into the mica lantern. A shrill whistle produces very fine serrations invisible thirty feet away. The human voice at ordinary loudness produces serrations two or three inches deep round the ring. A modified capsule placed upon the various parts of a vibrating body serves to investigate their modes of vibration, nodal points, &c.

SOME curious experiments on the magnetic behaviour of elder-pith have lately been made by M. Ader. Pith-balls placed in a powerful magnetic field are strongly attracted.

PROF. ROWLAND contributes a long and careful memoir upon thermometry and the mechanical equivalent of heat to the *Transactions* of the American Academy of Arts and Sciences. His results differ by about ·25 per cent. from the accepted numerical determinations of Joule's equivalent. Amongst other matters noticed in this memoir is an alleged decrease in the specific heat of water at higher temperatures.

A CONTEMPORARY gives the following method of illustrating the indestructibility of matter:—Two sealed glass tubes of equal weight, one of them containing oxygen and a little powdered charcoal, are prepared. The charcoal may be caused to burn away completely by heating it by means of a small flame. On placing the two tubes on a balance it will be seen that there has been no variation in weight.

THE process of electrodeposition is now finding a useful application in the production of bronze statuary, where it promises to supersede the process of casting. The Electrometallurgical Company of Brussels have just produced a colossal statue of Van

Eyck by the deposition of copper electrically upon the clay model. The production of bronzes may be readily carried out on a small scale by the following process communicated to the *Natural History Journal*, and which possesses some elements of novelty. Take any plaster figure or group, boil in sterine, then blacklead and plunge in a copper bath. Attach a very weak battery, and deposit very slowly a *thin* coating of copper. Now remove from the bath, and bake in an oven until the plaster model shakes out in dust. You have now a very thin copper reproduction of your model. Varnish this outside so as to prevent the further deposition, and replace in the bath. The copper will now be deposited on the inside surface, and you can thicken up to any desired point. For this second process a much stronger battery may be used.

MM. Leclerc and Vincent have described to the Physical Society of Paris an electrical instrument which will automatically record the notes played upon a piano. It can be adapted to a piano of any construction.

Clöe's thermoelectric pile has been recently improved by an addition which obviates the injurious effect of sudden and excessive heating of the junctions arising from alteration in the pressure of the gas. This safety-apparatus consists of a small glass vessel about half filled with water, and closed by a cork stopper, through which pass two tubes, one going to the bottom and being a branch of the tube by which the gas comes to the pile, while the other is shorter, and conducts any gas that may pass through it from the vessel to a gas-burner on another branch constantly lit. If the pressure of the gas is weak the water closes the mouth of the longer tube; if it increases the gas issues in bubbles in the liquid and rises through the shorter tube to the gas jet, where it is lit. The arrangement is a sort of safety-valve, and prevents the pressure from exceeding a certain amount, which is regulated at will.

M. Marcel Deprez has devised an ingenious apparatus for transmitting a movement of rotation by electricity. The apparatus is composed of a transmitter and a receiver. The transmitter consists of two ordinary split-collar commutators set upon a common axis, but adjusted at right angles to each other. The receiver consists of two longitudinal armatures carrying coils of wire as employed in the earlier Siemens' magneto-electric machines. These also run on a common axis and in positions at right angles to one another: and they are placed in the magnetic field between the poles of a permanent magnet. Currents generated by a battery pass through the transmitter and are conveyed by wires to the receiver. For every position of the axis of the transmitter there is one position—and one only—of stable equilibrium for the axis of the receiver. Hence the axis of the receiver follows all the movements of the transmitter; turns at the same rate and in the same direction as the transmitter may be turned; and makes the same number of revolutions precisely to within a quarter of a revolution.

GEOGRAPHICAL NOTES

The new number of the Geographical Society's *Proceedings* is chiefly occupied with a narrative of Lieut. G. T. Temple's voyage on the coasts of Norway and Lapland, illustrated by a map on which the depths of the ocean are well shown in colour, and by Mr. E. Hutchinson's account of Mr. Ashcroft's ascent of the River Binué last August, with remarks on the systems of the Rivers Shary and Binué. With the latter paper is given a reduction of Mr. Flegel's map of the Upper Binué from his own surveys, recently issued by Hellfarth of Gotha. An interesting letter from Mr. Thomson is afterwards given, furnishing information as to the progress of the East African Expedition. Among the geographical notes may be mentioned a summary of the most recent rumours respecting Prejevalsky and a description of routes from Dzungaria into Tibet. There is also an account of a visit paid by Mr. Woolley, of the Consular service, to the Island of Tsushima and Corea, and of the Rev. J. Chalmers's recent explorations in the interior of New Guinea, in the course of which he traversed a considerable extent of previously unknown country. The notes are followed by a communication on the "Tal-Chotiali Route from India to Pishin and Candahar," furnished by Mr. G. W. Vyse, who was attached to the Tal-Chotiali Field Force, in correction of previous statements made respecting this route.

By a note received on April 28 we learn that the Howgate Arctic Expedition Bill passed the House of Representatives at Washington on the 15th inst., and has gone to the Senate for final action. "This is a great step in advance, and augurs well for Government aid to the Expedition."

Under the title of "La Exploradora" an association has been formed in Spain, through the instrumentality of Señor Don Manuel Iradier, for the exploration and civilisation of Central Africa, and in furtherance of its objects commenced the publication of a *Boletin* in March. This association proposes to despatch an expedition from the west coast with what appears to be a somewhat ambitious programme. Its starting-point would be the Bay of Corisco, whence it would traverse the Sierra de Cristal, and afterwards march by way of Mount Onschiko and the River Eyo towards Lake Albert. If successful so far, it would then visit Mount Gambaragara, in the Usongora range, to study the peculiar population said to be found there. Then, turning in a north-westerly direction, it would make its way back to the Gulf of Guinea by Lake Liba and the Cameroons River. It is proposed that this expedition should start at latest during the month of June, but we are not aware whether the necessary funds for its journey of fourteen months have been provided. In the course of their march it is intended that the members of this expedition should devote themselves to the study of all the important problems yet unsolved in the central region of the African continent, and especially whether there be any connection between Lake Liba and the rivers Shary and Binué.

It is stated that the Comte de Semellé is about to return to Africa, in order to undertake an exploring expedition up the river Binué.

Dr. Regel, director of the Imperial Botanical Garden of St Petersburg, gave an account of the Flora of Turkestan at a recent meeting of the St. Petersburg Horticultural Society. Turkestan may be divided into two distinct parts—the west, with a very mild climate, and the east, the climate of which is almost that of St. Petersburg. The flora of Turkestan is exceedingly varied, much resembling that of Central Asia; plants proper to the climate of Europe grow there in small numbers. The eastern part abounds in Alpine specimens, and in general its vegetation approaches that of Europe, although quite as often plants are met with which are the sole product of Central Asia. Turkestan possesses neither lily nor tulip, and has very few conifers.

Last week we referred to Mr. E. Whymper's mountaineering exploits in South America. Some further details are given by Mr. Whymper himself in a letter to Mr. F. F. Tuckett in Tuesday's *Times*. It is dated from Quito, March 18. He says:—"You will be glad to hear that I have succeeded in polishing off Chimborazo, Corazon, Sincholagna, and Antisana. We have also passed twenty-six consecutive hours on the top of Cotopaxi. This last I reckon a feat, and I am not aware that any one has ever before encamped at so great an altitude as 19,500 feet. Antisana is the most difficult of those we have been up, and few more difficult ascents have ever been made. We are now going off to Cayambe, the mountain on the Equator, and shall try on the same journey to polish off Saranen and Cotocachi. Cayambe is thought to be an active volcano, but it is not certain that this is the case, neither is its height well determined. The height of Saranen is not known, but it *is* high. Cotocachi is the volcano which destroyed Ibarra some years ago, and is reputed to be 16,300 feet high. We have grown out of being affected by rarefaction of the air, and can be quite gay and lively at 19,000 feet. At first I was fairly knocked over by it, and was rendered quite incapable. The Carrels also were nearly as bad. The climate of Ecuador is the most utterly abominable that can be imagined. We have not had one single day fine from beginning to end, and not one view from a mountain top. An hour of clear weather from 6 to 7 a.m. is the most you can reckon on, and after that everything is bottled up in a mist. We carry about mercurial barometers everywhere, and boil water to an extent that would delight your heart."

In the May number of their *Chronicle* the London Missionary Society announce the departure, on April 16, of a new expedition for East Central Africa, to reinforce the weakened and scattered party now there. The Rev. A. J. Wookey goes to join Mr. Hore at Ujiji, the Rev. D. Williams to Urambo, where Dr. Southon now is, and Mr. W. S. Palmer, a medical missionary, to Uguha, where, we presume, he will be stationed at Mtowa, near the Lukuga Creek.

In their just-issued eighty-eighth Report the Committee of the Baptist Missionary Society summarise the efforts of their

Congo Expedition to reach Stanley Pool by way of San Salvador and Makuta. Owing to tribal jealousies, the Makuta route has had to be given up, but fresh efforts are now being made to discover some other route to the Upper Congo by Zombo or Sanda; or should these prove unfavourable, to strike out an altogether new road, and so to reach Stanley Pool over hitherto untrodden ground. By latest advices it seems probable that they may be able to get there by Sanda (about two days' journey from Makuta), where Messrs. Comber and Crudgington have been well received, and have been allowed to establish a station.

A "THÜRINGER WALD" Club, similar to the various Alpine clubs, has recently been formed at Eisenach. An "Erzgebirge" Club is in course of formation at Joachimsthal (Bohemia). A Saxon Club for the closer investigation of the last-named mountain chain has existed for several years; also a "Rhöngebirge" Club. These clubs do great service to tourists and the general public, and would be well worth imitating in our own mountain districts.

MR. STANFORD has issued three nicely-printed maps in which the results of the recent elections are very clearly shown for England, Scotland, and Ireland. The maps have been designed by Miss E. Shaw-Lefevre.

MR. STANFORD has just published a "Geography for Little Children," by Mrs. Zimmern, which in a very simple and interesting way attempts to show the use of a map and teach some of the elementary points of physical geography. Its numerous attractive and quite original illustrations are an important feature. We have also received the forty-fifth edition of Cornwell's "Geography for Beginners."

SCIENTIFIC SERIALS

THE *Journal of Anatomy and Physiology, Normal and Pathological*, vol. xiv. Part 3, April.—Prof. Turner, the structure of the comb-like branchial appendages, and of the teeth of the basking shark (*Selache maxima*) (with a plate).—Dr. G. Thin, on the ganglion-cells of the elephant's retina.—Dr. J. H. Scott, on the structure of the style in the tongue of the dog.—Dr. A. H. Young, on the anatomy of the Indian elephant.—Dr. C. Creighton, illustrations of the pathology of sarcoma, from cases of subcutaneous cystic tumours (three plates).—Dr. Dreschfeld, on a peculiar form of liver tumour (with a plate).—On a case of cerebellar tumour (with a plate).—Dr. T. Oliver, post-mortem in a case of extreme obesity.—Prof. J. Young, on the head of the lobster (with a plate).—W. S. Richmond, new abnormalities of the arteries of the upper extremity, with a plate.—Dr. R. J. Anderson, abnormal arrangement of the thyroid arteries (with a plate).—On a variety of the mylo-pharyngeus and other unusual muscular abnormalities.—Drs. P. M'Bride and A. Bruce, the pathology of a case of fatal ear-disease (with a plate).—Dr. F. Shepherd, notes on the dissection of a case of congenital dislocation of the head of the femur.—J. D. Brown, abnormal cystic artery.—Anatomical notes.

Journal of the Royal Microscopical Society, vol. iii. No. 2, April, 1880.—A. D. Michael, a further contribution to the knowledge of British Oribatidæ, Part 2, with the assistance of C. F. George (two plates).—Dr. Lionel S. Beale, annual address as president.—J. W. Groves, on a means of obviating the reflection from the inside of the body tubes of microscopes, with suggestions for standard gauges for the same and for sub-stage fittings.—A. Nachet, on a petrographical microscope.—The record of current researches relating to invertebrata, cryptogamia, microscopy, and bibliography.—Proceedings of the Society.

Revue Internationale des Sciences, April.—M. Gilkinet, on the development of the vegetable kingdom in geological times.—A. de Bary, on apogamous fungi, and on apogamy in general.—R. Blanchard, on striated muscles in the monomyary acephalous mollusks, and on the peritoneum of Seba's python.

THE *American Naturalist*, vol. xiv., No. 3, March.—G. Macloskie, the proboscis of the house-fly.—E. Coues, sketch of progress in mammalogy in the United States in 1879.—E. D. Cope, a review of the modern doctrine of evolution, being an abstract of a lecture delivered before the Californian Academy of Sciences (with several cuts of crania of Anura).—E. A. Smith, a paper concerning amber.—Notes on recent literature, General Notes, and Scientific News.

No. 4, April.—W. S. Barnard, protoplasmic dynamics (an attempt to find a clue "to the mode in which molecular movement is transformed into the movement of masses").—C. S. Minot, a sketch of comparative embryology (II., the fertilisation of the ovum).—C. A. White, on the progress of invertebrate palæontology in the United States for the year 1879.—E. D. Cope, a review of the modern doctrine of evolution (concluded).—A. J. Cook, on the tongue of the honey-bee.—Notes on recent literature, General Notes, Proceedings of Scientific Societies.

Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien, vol. xxix. Part ii., June to December, 1879, Vienna, 1880, contains, besides list of members and minutes of the Proceedings, the following memoirs:—Otto Bohatsch, supplement to the lepidopterous fauna of Syria.—H. Wichmann, the minute anatomy of the seeds of *Aleurites triloba*, Forst. (two plates).—Dr. J. Csokor, on the pimple mite, and on a new variety of the same occurring in swine (*Demodex phylloides*), one plate.—H. Leder, contribution to the coleopterous fauna of the Caucasus.—S. Schulzer, mycological notes, iv.—E. Reitter, the synonomy of coleoptera; contributions to a knowledge of the European Pselaphidæ and Scydmænidæ: on new coleoptera from South-West Russia; on Spelæodytes, Mill.—Dr. H. Loew, analytical table to determine the North American species of Pachyrrhina, a genus of Tipulidæ.—C. R. Osten-Sacken, the Tanyderina, a remarkable group of the Tipulidæ.—F. von Thümen, two new leaf-frequenting ascomycetes, from Vienna.—A. von Pelzeln, on a fifth package of birds from Ecuador; on Dr. Breitenstein's collection of beasts and birds from Borneo.—Dr. F. Löw, notes on Psyllodidæ (with a plate); descriptions of new gall-insects, with notes on some species already known.—Dr. R. Bergh, contributions to a monograph of the Polyceridæ (with six plates).—W. Voss, materials towards a knowledge of the fungi of Carniola.—Dr. G. Mayr, on the ichneumon-wasp of the genus Telenomus.

THE *Zeitschrift für wissenschaftliche Zoologie*, xxxiv. Band, Heft 1, March.—Dr. Ernst Nauck, on the masticatory apparatus of the Brachyura, with a plate and woodcuts.—Dr. Hubert Ludwig, on *Asthenosoma varium*, Grube; and on a new organ in the Cidaridæ, with two plates and woodcut. Describes three specimens from the Museum Godeffroy, one possibly a variety of *A. varium*, or possibly a new species, and describes five sac-like organs which lie, like the radial Y-shaped manubria (Gabelstücke), in the plane of the ambulacra. These he calls the cœcal sacs (Blindsacke) of the masticatory apparatus. Each cœcal sac consists of a thin membrane, stiff with calcareous spicules; right and left of each of these there lie two other blind appendages, but very much smaller; they were first detected in *Cidaris tribuloides*, but were also found in *C. metularia*, *Dorocidaris papillata*, and *Goniocidaris canaliculata*. A slight trace of their existence was found in *Diadema setosum*, but they were quite absent in the families Echinometridæ and Arbaciadæ.—Prof. Dr. P. Langerhans, on the worm fauna of Madeira; part 3, with three plates (to the end of the Nemerteans).—The same, on the Madeiran Appendicularia.—Dr. H. von Ihering, on *Graffilla muricicola*, a new parasitic Rhabdocœlian, with a plate (found in the kidney of *Murex trunculus* and *M. brandaris*, both at Naples and Trieste).

THE *Revue des Sciences Naturelles*, 2e série, tome 1, No. 4, March 15.—Dr. A. Godron, on the axillary buds and branches in the Gramineæ.—L. Tillier, essay on the geographical distribution of marine fishes (conclusion).—S. Jourdain, on the morphology of the early stage of the generative organs of *Helix aspersa*, with a plate.—M. Leymerie, sketch of the Pyrenees of the department of Aude (in continuation), with a plate.—A Sabatier, the law of the correlation of forms and intermediate types.—E. Dubrueil, catalogue of the land and fluviatile mollusca of the department of Herault (conclusion).—Review of recent French works on zoology by Messrs. Jourdain, Rouzaud, and Dubrueil, and on botany and geology by M. Dubrueil.

Rivista Scientifico-Industriale, March 15.—Note on electricity and earthquakes, by Prof. De Bosis.—Researches on the diathermanous power of films of soapy water, by Prof. Marangone.

Archives des Sciences Physiques et Naturelles, March 15.—Swiss geological review for 1879 (continued), by M. Favre.—Enigmatic descriptions of natural groups, by M. de Candolle.—New observations on philippium, by M. Delafontaine.—On decipium and its principal compounds, by the same.—Earthquakes and their scientific study, by M. Heim.—On the density of chlorine at high temperatures, by M. Crafts.

SOCIETIES AND ACADEMIES

London

Royal Society, April 22.—"Effects of Electric Currents on the Surfaces of Mutual Contact of Aqueous Solutions." By G. Gore, LL.D., F.R.S.

In the year 1859 I made the following experiments, for the purpose of ascertaining whether visible movements, similar to those obtained by passing an electric current through mercury and an aqueous solution, could be obtained by passing a current through the surface of mutual contact of two aqueous liquids alone:—"1. A definite layer of oil of vitriol was placed beneath a layer of distilled water weakly acidulated with sulphuric acid, and the terminal wires of a voltaic battery immersed in the upper liquid; no visible movements occurred at the boundary line of the two liquids.

"2. A dense solution of cyanide of potassium was placed in a small glass beaker, a few particles of charcoal sifted upon its surface, and a layer of aqueous ammonia, half an inch deep, carefully poured upon it. A vertical diaphragm of thin sheet gutta-percha was then fixed so as completely to divide the upper liquid into two equal parts; the vessel was placed in a strong light, and two horizontal platinum wire electrodes, from sixty-six freshly-charged Smee's cells, were immersed one-eighth of an inch deep in the liquid ammonia on each side of the diaphragm. A copious current of electricity circulated, but no movement of the liquids at their mutual boundary line could be detected" (see *Proc. Roy. Soc.*, vol. x., 1860, p. 235, par. 9).

Recently, also, I have made similar experiments, but in a much more searching manner, in order to ascertain whether an electric current, passing between two aqueous liquids, affects their diffusion into each other. The essential difference in the form of these experiments from that of the above-mentioned ones was to concentrate the action of the current upon a very much smaller surface of contact of the liquids, and thus render any visible effect upon their diffusion more manifest.

After making several forms of apparatus, in order to obviate certain difficulties of manipulation which arose and were fatal to success, I found that, when an electric current was passed between the surfaces of mutual contact of certain aqueous solutions of different specific gravities, the boundary line of contact of the two liquids became indefinite at the surface where the current passed from the lighter into the heavier solution, and became sharply defined where the current left the heavier liquid and re-entered the lighter one; and that on reversing the direction of the current several times in succession after suitable intervals of time, these effects were reversed with each such change. Also, in various cases in which the contiguous boundary layers of the two liquids had become mixed, the line of separation of the two solutions became, by the influence of the electric current, as perfect as that between strata of oil and water lying upon each other. In rarer cases two such distinct lines of stratification appeared. Other new phenomena were also observed.

As I have sought, without success, for any record of previous discovery of essentially similar effects, and as it is evident that those I have observed belong to a large class of similar phenomena, I beg leave to take the earliest opportunity of submitting this brief statement to the Royal Society.

"Revision of the Atomic Weight and Valence of Aluminium," by J. W. Mallet, F.R.S.

The general mean from all the experiments, if all be included, is Al = 27·032, with a probable error for this mean of ± ·0045. If Series I, B, be excluded, the mean of all the remaining twenty-five experiments is Al = 27·019, with a probable error of ± ·0030.

The general result adds, the author hopes, aluminium to the, unfortunately still limited, list of those elementary substances whose atomic weights have been determined within the limits of precision attainable with our present means of experiment.

This result also adds one to the cases already on record of the numbers representing carefully determined atomic weights approaching closely to integers, and leads the author to say a word on the reconsideration of "Prout's Law." Taking the following eighteen elements as the only ones of which the atomic weights may be fairly considered as determined, with reference to hydrogen, with the greatest attainable precision, or a near approach thereto, namely, oxygen, nitrogen, chlorine, bromine, iodine, sulphur, potassium, sodium, lithium, silver, thallium, aluminium, carbon, phosphorus, barium, calcium, magnesium, and lead, and making a reasonable allowance for the errors of the determinations, he calculates the probability that nine of those numbers should lie, as they are found to do, within 0·1 of integers, supposing the value of the true numbers to be determined by chance, and finds it only as 1 to 235·2. The exact figure for the chance will of course depend upon the limit of error taken; but the above example seems sufficient to show that not only is Prout's law not as yet absolutely overturned, but that a heavy and apparently increasing weight of probability in its favour, or in favour of some modification of it, exists, and demands consideration.

Chemical Society, April 15.—Prof. H. E. Roscoe, president, in the chair.—The following papers were read,—On the lecture illustration of chemical curves, by E. J. Mills. The author has contrived an apparatus for exhibiting the variations in the actions of sulphuric acid on zinc and sodic hydrate on aluminium, produced by alterations (1) in the strength of the solution, (2) in the time during which the action is allowed to proceed. The gas evolved is collected in a series of inverted glass cylinders filled with water, arranged at equal distances. The surfaces of the water levels after the gas has been collected form a curve.—On the analysis of organic bodies containing nitrogen, by W. H. Perkin (continued). The author finds that a mixture of precipitated manganic oxide and potassium chromate (containing 10 per cent. of bichromate) in about equal parts kept at a temperature of 200°–250° C. is preferable to the chromate alone for absorbing the oxides of nitrogen.—On the volatilisation of solids in vacuo, by W. D. Herman. The author has obtained adamantine colourless transparent crystals of phosphorus by volatilising ordinary phosphorus in vacuous glass tubes in the dark. The crystals may be as long as 8 mm.; they turn red in sunlight. Similar experiments have also been made with sulphur, selenium, &c.—On the determination of nitric acid as nitric oxide by means of its reaction with ferrous chloride, by R. Warington. The author describes an apparatus for the above purpose. The air is expelled by carbon dioxide, the nitrate heated by a calcium chloride bath to 135° C., and the nitric oxide measured as gas; organic matter does not affect the results.—On the six possible isomeric dibromtoluols and other of the bromo- and bromonitro derivatives of toluol related thereto, by R. Nevile and A. Winther. The authors criticise the results of Wrobleosky, *Jahr.*, 1870, 528, and 1871, 450, and establish the conclusion that in such bodies the bromine never occupies a position which is "meta" to the amido group.

Zoological Society, April 20.—Prof. W. H. Flower, F.R.S., president, in the chair.—Prof. Owen, C.B., read descriptions of some new and rare Cephalopoda, to which were added notes on the occurrence of gigantic species of this group.—A second paper was read by Prof. Owen on the external and structural characters of the male of *Spirula australis*.—Dr. M. Watson read a paper on some points in the anatomy of the Proboscidea, in which he described the structure of the female organs of the Indian elephant, as observed in a specimen recently dissected.—Lieut.-Col. H. H. Godwin-Austen read a paper on the land-molluscan genus '*Girasia* of Gray, and made remarks on its anatomy and on the form of the "*capreolus*" of Lister or the spermatophore, as developed in species of this genus of Indian Helicidæ.—A communication was read from Dr. Max Schmidt on the duration of life of the animals in the Zoological Garden of Frankfort-on-the-Main.—A communication was read from the Rev. O. P. Cambridge, C.M.Z.S., containing descriptions of new or little-known spiders of the genus *Argyrodes*.—A communication was read from Mr. Edgar A. Smith containing an account of a collection of the shells of Lake Tanganyika, and of the neighbourhood of Ujiji, Central Africa, made by Mr. E. C. Hore, of the London Missionary Society. Twenty-one species were represented in this collection, amongst which were two new generic forms proposed to be called *Tiphobia horei* and *Neodauma tanganyicensis*.

Geological Society, April 14.—Robert Etheridge, F.R.S., president, in the chair. Colville Brown, John N. Dufty, and George Benjamin Nichols were elected Fellows of the Society.—The following communication was read:—On a new Theriodont Reptile (*Cliorhizodon orenburgensis*, Twelvetr.) from the Upper Permian Sandstone of Kargalinsk, near Orenburg, in South-Eastern Russia, by W. H. Twelvetrees, F.L.S. The above measures are cupriferous, and rest on limestone with Zechstein fossils. Associated with the remains of Saurians and Labyrinthodonts are *Calamites*, *Lepidodendron*, *Aroides crassispatha*, Conifers, and a *Unio*. The specimen noticed in this

paper is apparently the dentary part of the left mandibular ramus, with the crowns of a canine, an incisor, and ten of the molars. The author describes the characteristics of these and the mode of implantation in the jaw, which accords with that described by Prof Owen in *Titanosuchus ferox*. The characters of this specimen resemble those of the genus *Rhopalodon;* but as there are some marked differences, the author proposes to name it *Cliorhizodon orenburgensis*.—The classification of the Tertiary period by means of the mammalia, by Prof. W. Boyd Dawkins, F.R.S., Professor of Geology in Owens College. The author, after some introductory remarks on the value of vertebrata and invertebrata in classification, pointed out that the mammalia become of especial value in the Tertiary period as undergoing more rapid change than the other classes, from their being, as it is happily termed, *en pleine évolution*. He discussed the characteristics of each of the great periods, as defined and limited by their mammalia, pointing out that throughout the Eocene these frequently exhibit relations more or less marsupial. Indeed it is not till the close of the Lower Miocene that the traces of this relationship are lost. In the Middle Miocene, *Sus*, *Cervus*, *Antilope*, *Felis*, *Lutra*, and *Castor* appear for the first time, and the higher apes were present in European forests. In the Upper Miocene, *Camelopardalis*, *Gazella*, *Hyæna*, and *Hystrix* appear. During the Pliocene several important genera disappear from the world or from Europe—among the latter the apes, at the close of the Upper Pliocene. Oxen, horses, bears, and elephants appear. Great changes took place in the Pleistocene; seven species survived into it which are now extinct, and of new-comers there were fourteen living and seven extinct species. *Cervus megaceros* is the sole survivor from the Pleistocene to the prehistoric period which has since become extinct. The paper concluded with some remarks on the latter part of the first and the second period, which, however, as forming the subject of previous notices, was treated more briefly. The author remarked that a study of the development of the mammalia renders it hopeless to expect to find man in the Eocene or Miocene, and improbable in the Pliocene.

Anthropological Institute, April 13.—Major-General A. Lane Fox, F.R.S., vice-president, in the chair.—The director read a paper on Fijian Burial Customs, by the Rev. Lorimer Fison. There is no uniformity of custom in Fiji, so that no description of what is done by any one tribe can be taken as applicable to all the others. The strangling of widows, however, that they might be buried with their dead husbands, seems to have been everywhere practised. The widow's brother performs the operation, and is thenceforward treated with marked respect by his brother-in-law's kinsfolk, who present him with a piece of land over which the strangling-cord is hung up. Should he, however, fail to strangle his sister, he is despised and ashamed to show his face. When a woman is about to be strangled she is made to kneel down, and the cord (a strip of native cloth) is put round her neck. She is then told to expel her breath as long as possible, and when she can endure no longer to stretch out her hand as a signal, whereupon the cord is tightened, and soon all is over. It is believed that, if this direction be followed insensibility ensues immediately on the tightening of the cord; whereas if inhalation has taken place, there is an interval of suffering. An excuse for the practice of widow-strangling may be found in the fact that according to Fijian belief, it is a needful precautionary measure, for at a certain place on the road to Mbulu (Hades) there lies in wait a terrible god, called Nangga-nangga, who is utterly implacable towards the ghosts of the unmarried. He is especially ruthless towards bachelors, among whom he persists in classing all male ghosts who come to him unaccompanied by their wives. Turning a deaf ear to their protestations, he seizes them, lifts them above his head, and breaks them in two by dashing them down on a projecting rock. Women are let off more easily. If the wife die before her husband, the widower cuts off his beard and puts it under her left armpit. This serves as her certificate of marriage; and, on her producing it to Nangga-nangga, he allows her to pass. On the island of Vanua Levu a noted "brave" is distinguished from the common herd after death by being buried with his right arm sticking out above the grave-mound, and passers-by exclaim with admiration as they look upon the fleshless arm, "O the hand that was the slayer of men!" For some days after the decease of a ruling chief, if his death be known to the people, the wildest anarchy prevails. The idea seems to be that not until decomposition may be supposed to have made considerable progress is the dead man fairly done with, and his authority handed over to his successor. Hence the death of a ruling chief is studiously concealed for a period varying from four to ten days. By many tribes the burial-place of their chief is kept a profound secret, lest those whom he injured during his lifetime should revenge themselves by digging up and insulting, or even eating, his body. Hence the surface sods are raised with extreme care, in order that they may be replaced with as little derangement as possible. Cave burial is common in Fiji, although by no means universal; in some cases artificial caves are made, either in the side of a hill, or by sinking a perpendicular shaft, and then putting in a "side drive," as the Australian gold-diggers call it; this forms the grave, and here the chief lies with his strangled women under him. A stone closes the entrance of the chamber and excludes the earth when the shaft is filled up. On the death of the king of the Nakelo tribe three old men come, with fans in their hands, and conduct the spirit to the banks of the river. Here they call upon Themba—the Nakelo Charon—to bring over his canoe, and wait until they see a wave rolling in towards the shore, which they say is caused by the approach of the invisible canoe; they then avert their faces, point their fans suddenly to the river, cry aloud, "Go on board, sir," and forthwith run for their lives, for no eye of living man may look upon the embarkation. The grave is dug about hip deep, the body laid in it, and an old cocoanut is broken by a blow with a stone, being so held that the milk runs down upon the head of the corpse. The meat of the nut is then eaten by the three elders, and the grave is filled up.—A paper on the Polynesian Race, by C. Staniland Wake, M.A.I., was read. The author proposed to show, first, that the Polynesian Islanders must be described as a bearded rather than a non-bearded race, and secondly, that, as a rule, they are well acquainted with the use of the bow and arrow, and quoted the observations of numerous travellers in support of his view.—Major-General A. Lane Fox, F.R.S., exhibited some paintings and bead mats, the work of Bushmen.

Physical Society, April 24.—Prof. W. G. Adams in the chair.—New members:—The Marquis of Blandford, Mr. J. Marshall.—Prof. G. C. Foster read a note by Prof. Rowland, of Baltimore, U.S., on the discovery of Mr. Hall that a magnet exercises an electromotive on a current in a conductor crossing its field, as well as a force on the conductor itself. This fact will render it necessary to apply a correction to equations which assume that only the latter force acts. The electromotive force in question is at right angles to the direction of the current and to the lines of magnetic force. Prof. Rowland expresses it mathematically in this note, and bases a new method of determining the value of v, the ratio of the electrostatic to the electromagnetic unit of electricity, which gives v almost identical with the velocity of light, thus confirming Clerk-Maxwell's theory of the nature of light. Dr. J. Hopkinson, F.R.S., suggested an expression for one of Prof. Rowland's results.—Prof. Foster also read a note by Prof. Wild, of the Central Russian Meteorological Observatory, on a mode of correcting the bifilar magnetometer for torsion of its fibres, &c., and a method for finding the horizontal component of the earth's magnetism by its aid.—Mr. Ridout, F.C.S., described an improved thermo electric apparatus of his construction. The author has followed the idea of combining the thermopile and galvanometer in one instrument on the same base-board. The defects of the apparatus as ordinarily made are a too great disparity between the resistance in the pile and in the galvanometer; the junctions of the pile are too deep, and short-circuit the current; the bars too long and resisting, as well as too numerous; the junctions too slender; the mass of matter to be heated too great. These defects are remedied by placing the bars in glass tubes connected with these plates of copper; making the bars half the usual length, and using only a single pair. The defects in the galvanometer are that the wire does not come near the needle; the needles are not of the best form, and the suspension is troublesome. Mr. Ridout makes the wire a flat ribbon mounted on one bobbin; the needles are flat oblong plates from the same piece of steel, and magnetised in one piece; they are mounted on a pivot turning in an agate cup. The several parts of the apparatus are mutually adapted to each other; and in using it the galvanometer is not joined to the pile till the latter has been exposed to the heat, so as to prevent the current generated abstracting heat from the hot side. As made by Mr. Browning, the pile consists of a pair of elements $\frac{1}{2}$ in. long, the copper connections being circular plates $\frac{1}{100}$ in. thick and $\frac{5}{8}$ in. diameter. The pile is supported by thick copper terminals

above the galvanometer, which consists of a copper ribbon making some twenty turns round a pair of astatic needles 1m. long and $\frac{1}{8}$ in. broad, pivoted in an agate cup. A contact-key is placed on one side, and the whole is inclosed in a glass shade perforated opposite the pile. A glass cone protects the front from extraneous heat, and a glass case the back. A directing magnet is fixed above the pile. Contact between the galvanometer and pile is made after (say) 30 seconds' exposure to the heat. The pile is affected by a person standing six feet from it, and the radiation from stellar space is evident in clear weather. Half a minute is sufficient to put the instrument ready for use.—Mr. Ridout also exhibited laboratory experiments showing cohesion in mercury by causing it to overflow up an inclined trough; electrolysis of water by a single Grove or bichromate cell, through diminishing the pressure in the flask containing the water by boiling it and condensing the vapour on cooling; a differential thermometer showing absorption of heat on liquefying solids; and the production of musical notes in glass tubes by contracting the bore smoothly to about $\frac{1}{4}$ of the diameter at one part. Prof. Foster remarked that the cohesion experiment might show the surface-tension. Prof. Guthrie and Prof. Hughes offered remarks on the electrolytic experiment, the latter stating that he finds the resistance of an iron cell he has constructed to depend on the electrodes rather than the liquid; when the negative plate is tempered iron the resistance is low, when soft iron it is high.—Prof. Stone exhibited photographs of König's new tonometer described by him at the last meeting, and further mentioned that König had devised a thermometer based on the principle that changes of temperature produce corresponding changes in the vibration rate of a tuning-fork. The temperature is found from the rate of the fork by bringing it to a zero rate by means of a rider.—Prof. Michin then described his experiment to solve the problem of transmitting light by photo-electric action. Two years ago he conceived the idea of employing for this purpose the fact that light falling on a sensitised silver plate disengages electricity. He forms a sensitive cell composed of two silver plates immersed in a conducting solution; one plate is coated with a sensitive emulsion of chloride or bromide of silver. When chloride is used, a solution of salt in water forms the liquid; when bromide, a solution of bromide of potash. A current is set up in the cell even in the dark, but when exposed to the magnesium light the current is very powerful, and flows within the cell from the uncoated to the sensitised plate. Prof. Michin also conducted this current by wire to a second cell in a dark chamber, and found that it effected a decomposition of the sensitive plate in that cell, as shown by a distinct darkening of the plate when "developed" by pyrogallic acid. The same effect was produced whether the current was reversed or not. Prof. Michin is continuing his experiments, and has provided a cable containing a number of separate conductors insulated from each other, in order to convey the currents from several cells. Prof. Perry feared that the effect would not be strong enough; but Prof. Michin said the light of a match produced a decided photo-electric effect in the cell. Prof. Perry alluded to the selenium plan proposed by himself and Prof. Ayrton, and said that Mr. Willoughby Smith had observed selenium to be sensitive to the shadow of a flying swallow. Prof. Adams testified to the sensitiveness of selenium and its power of being directly excited by light, a fact first proved by the experiments of Mr. Day and himself.

Entomological Society, April 7.—H. T. Stainton, F.R.S., vice-president, in the chair.—Messrs. G. C. Bignell, W. D. Cansdale, Frank Crisp, and the Rev. W. Fowler, were elected Ordinary Members, and M. E. André a Foreign Member.—Mr. J. T. Carrington exhibited a pale variety of *Arctia caja* which was bred by a gentleman at Croydon, who had been experimenting upon the effects of the rays of light transmitted through glasses of various colours upon this species. The specimen exhibited had been reared under green glass, but there was no evidence to show that the variation was due to the green rays. —The Secretary read a communication from Mr. Rothney, of Calcutta, on insects destroyed by flowers, with reference to a note on this subject published in the *Proceedings* of last year by Mr. J. W. Slater.—The following papers were read:—Notes on the coloration and development of insects, by Peter Cameron; on two gynandromorphous specimens of *Cirrochroa aoris*, Dbl., an Indian species of mymphalideous butterflies; and on *Cetonia aurata* and *Protactia bensoni*, by Prof. Westwood. Specimens and drawings were exhibited in illustration of the last paper, showing the specific distinctness of the insects in question.

Meteorological Society, April 21.—Mr. G. J. Symons, F.R.S., president, in the chair.—Rev. J. O. Bevan, M.A., F. E. Cobb, E. Filliter, F.G.S., T. L. Gentles, W. A. Harrison, F.R.G.S., J. W. Peggs, F. Slade, and E. J. C. Smith, were elected Fellows of the Society.—The discussion on Mr. Ellis's paper, on the Greenwich sunshine records, 1876-80, was resumed and concluded.—The following papers were read:—On the rate at which barometric changes traverse the British Isles, by G. M. Whipple, B.Sc., F.R.A.S., F.M.S.—A new form of Six's self-registering thermometer, by J. W. Zambra, F.M.S.

EDINBURGH

Royal Society, April 5.—Sir Wyville Thomson, vice-president, in the chair.—Mr. John Murray, of the *Challenger* Expedition, occupied the evening with an interesting and exhaustive paper on the structure and mode of origin of coral reefs and islands. After detailing the well-known and widely-accepted theory of Darwin, Mr. Murray proceeded to take exception to its general truth, and to substitute a new theory, which, in the light of the recent discoveries of the *Challenger* Expedition, appeared at once simpler and more consistent with the facts. The main features of this theory were as follows: The abundant pelagic life of the ocean was stated to be the chief food of the reef-building corals and of the deep-sea animals. Lime-secreting creatures were especially abundant in tropical oceanic waters. Tow-net experiments showed that in a cubic mass of the ocean one mile square by 100 fathoms, there were about sixteen tons of carbonate of lime in the form of calcareous Algæ, Foraminifera, pelagic Molluscs, &c. Although so abundant on or near the surface the dead shells of these organisms were quite absent from by far the greater part of the floor of the ocean. In all the greater depths they were removed during their fall or shortly after reaching the bottom by the action of carbonic acid, which was especially abundant in deep sea water. Other things being equal, they were found at greater depths where they were most abundant at the surface. On submarine elevations (which were probably all of volcanic origin) these dead shells were met with in great abundance: when the depth was less than a mile the shells and skeletons of almost every surface creature were present in the deposit. Mixed up with these we had in these deposits the shells and skeletons of deep-sea animals, as Echinoderms, Annelids, Polyzoa, Foraminifera, Corals, &c. In these more or less shallow depths the accumulation was relatively rapid, and the solvent action of sea water had consequently little effect. Eventually this bank reached near enough the surface to serve as a foundation for reef-building corals. As these corals built up to the surface those situated towards the outer margin of the coral plantation had a great advantage in the more abundant supply of food, and reached the surface first. If the coral-field or plantation were small (less than a square mile) the periphery was relatively large over which food came from the ocean, and from which detritus was carried to the interior; hence the interior was filled up and no lagoon was formed. The same was the case when the coral plantation was long and narrow. In larger coral-fields—the area increasing as the square and the periphery only in an arithmetic progression—the interior parts of the coral plantation were at a relatively great disadvantage, less food and less detritus for filling up were supplied per square mile, and in consequence a lagoon was formed. The carbonic acid in the sea water removed in solution the lime of the dead coral and coral rock from the lagoon. As the atoll extended seawards the lagoon was widened and deepened by the solvent and disintegrating power of the sea water. The structure of upraised coral atolls were referred to as confirming these views. Barrier reefs were explained on the same principles. Fringing reefs built seawards on a talus formed of their own *débris* and of surface shells and deep-sea shells and skeletons. A lagoon-channel was gradually formed by the solvent action of the sea water thrown over the reef at each tide. In this way the fringing reef became a barrier reef. Numerous sections of the reefs at Tahiti, from the survey of Lieut. Swire, of the *Challenger*, were exhibited. The structure of the interior overhanging reefs, and of the steep exterior submarine talus, were especially pointed out and explained. The chief features of barrier reefs and atolls were quite independent of subsidence, and would exist alike in stationary areas or in areas either of slow elevation or of slow subsidence. Throughout the volcanic islands of the great oceans the evidence of recent elevation was everywhere conspicuous, and the same was the case in regions of barrier

reefs and atolls, as shown by Dana, Jukes, Couthouy, Semper, and others. He would expect to find local areas of subsidence in the great ocean basins on either side of volcanic islands and atolls, and this is what the soundings of the *Challenger* and *Tuscarora* seem to show. On the other hand the lines of volcanic islands and coral islands had probably always been the sites of a gradual elevation, for it must be remembered that these last have probably almost all a volcanic basis. In all cases the great agencies are the growth of the coral where most nourishment is to be had, and its death and disintegration by the action of the sea at those parts which cannot be, on account of their situation, sufficiently supplied with nourishment. In many cases, however, this disintegration, by breaking up the reef, serves to so alter conditions that decaying parts get a new lease of life, and growth begins afresh where decay was formerly manifest. Mr. Murray applied his theory with singular success to the discussion of particular cases of coral islands, such as the Maldive Islands, the Chagos Archipelago, and the great barrier reefs of Australia. The special merit of the theory is that it does away with the great and general subsidences which is the peculiar feature of Mr. Darwin's theory. Of such subsidences there is no other evidence. These views were also in harmony with Dana's as to the great antiquity of the ocean basins. In a previous paper he had shown that a study of deep-sea deposits also argued for the permanency and great antiquity of these great ocean depressions. The co-existence of fringing and barrier reefs and of atolls in close proximity (*e.g.* in the Fiji Islands), which is not easily explained by Darwin's theory, offers no difficulty whatever when looked at in the light of Mr. Murray's principles. In the criticism which followed, Sir Wyville Thomson and Prof. Geikie spoke in terms of high commendation of the thoroughness which characterised Mr. Murray's paper, and the success with which he had been able to do away with the assumption which was the basis of Darwin's theory, but for the truth of which there was no positive evidence.

PARIS

Academy of Sciences, April 26.—M. Edm. Becquerel in the chair.—The following papers were read:—On the inverse problem of the motion of a material point on a surface of revolution, by M. Resal.—On the law of distribution, according to altitude, of the substance in the atmosphere absorbing ultra-violet solar radiations, by M. Cornu. The identity of this law (which he is able to determine very definitely) with the barometric formula, shows that the absorption is exercised by the gaseous mass and not by aqueous vapour or dust, which leads to different progressions.—Study of the explosive properties of fulminate of mercury, by MM. Berthelot and Vieille. It is simply decomposed into carbonic oxide, nitrogen, and mercury. The authors furnish data of the heat liberated, the density, and the pressures developed in a closed vessel. The superior force of the fulminate is attributed to the almost instantaneous nature of its decomposition by simple inflammation, the almost total absence of dissociation of the products, and the great density of the matter.—On the cholera of fowls; studies of the conditions of non-recurrence of the malady, and some others of its characters, by M. Pasteur. The aliments suited to the life of the microbe in the fowl disappear in consequence of inoculation with attenuated virus.—Observations of Schaberle's comet at Marseilles Observatory, by M. Stephan.—On the meteorite which fell on May 10, 1879, near Estherville (Emmet Co., Iowa, U.S.), by Prof. J. Lawrence Smith. He thinks this meteorite should be placed apart for the phenomena of its fall, especially the force of penetration of its fragments into the ground, and for the mode of association of its mineral constituents.—On winter barley as forage, by MM. Pierre and Lemetayer. It is rather the abundance and precocity of this cereal which renders it in demand, than its richness in azotised matter.—On appointment of a scientific commission for the Panama scheme. M. de Lesseps specified documents he would give them. The work in hand came to this: 75,000,000 cubic metres to be excavated; 8,000 workmen for six years; 250 working days each year, or 1,500 days, during which 50,000 cubic metres should be done each day.—*Apropos* of M. Bouty's note on thermo-electric currents from a metal and a liquid, M. Du Moncel recalled former experiments by M. Hellesen and himself.—Some considerations in support of a note of March 29 on the impossibility of supposing in general a function of velocities in every question of hydraulics where frictions have a notable *rôle*, by M. Boussinesq.—On the dependence of two electromagnetic gyroscopes submitted to the same circuit of induction, by M. de Fonvielle. The velocity of each movable piece is diminished.—The death of M. de Luca was announced.—The surface of the wave considered as a limiting surface, by M. Mannheim.—On the numerical calculation of definite integrals, by M. Baillard.—On simultaneous linear equations and on a class of non-plane curves, by M. Picard.—On the series F_3 (α, α', β, β', γ, x, y), by M. Appell.—Influence of temperature on the duration of period of a tuning-fork, by M. Mercadier. He corrects a numerical mistake in his memoir as quoted by Wiedemann (with whom he is in agreement).—On the theory of induction-currents, by M. Mascart.—On an experimental method fitted to determine the lines of surface in stationary flow of electricity through conducting surfaces, by M. Guébhard. At a short distance from a thin plate of metal in a mixed solution of acetate of lead and acetate of copper, are held the free ends of two conductors connected with a pile; thus a double system of Nobili's rings is produced of remarkable constancy and regularity, and in relation to the positions of the electrodes and the contour of the conducting surface.—Absolute measurement of Peltier's phenomenon on contact of a metal and its solution, by M. Bouty.—Measurement of the difference of potential of two metals in contact, by M. Pellat. The method (which has precision exceeding $\frac{1}{500}$ Daniell) is one of compensation, and its principle is, that if two metals, A and B, are connected by a metallic wire they take the same difference of potential as if they had been put directly in contact. The author studies the effects of varied surfaces of metals, change of temperature, and influence of gases round the plates.—On the theory of double circular refraction, by M. Gouy.—Influence of temperature on the compressibility of gases under strong pressures, by M. Amagat. When a gas is $\left\{\begin{matrix}\text{more}\\\text{less}\end{matrix}\right\}$ compressible than according to Mariotte's law, its compressiblity $\left\{\begin{matrix}\text{decreases}\\\text{increases}\end{matrix}\right\}$ with the temperature.—Researches on the passivity of iron (second part), by M. Varenne. *Inter alia*, an iron rod may be made passive by immersion of only a fraction of it in concentrated nitric acid, and passivity may be produced by prolonged immersion of iron in compressed bioxide of nitrogen.—On the proportion of iron in mineral waters of Rouen and Forges-les-Eaux, by M. Houzeau.—Isomers of phloroglucine, by M. Gautier.—On the products contained in coke of petroleum, by MM. Prunier and Varenne.—On a singular explosion produced during heating of wine, and on a new mode of determination of alcohol, by M. Wartha. This explosion was probably caused by inflammation of a mixture of alcohol and air in the tun. M. Wartha is seeking to determine the limit of explosion of such mixtures.—Synthetic reproduction of the aluminous silicates and alkaline silico-aluminates of nature, by M. Meunier.—On the origin and development of the egg in the Medusa Eucope before fecundation, by M. Merejkowsky.—On the apparent analogies between cholera of fowls and the malady of sleep (nelavan), by M. Talmy.

CONTENTS